Towards a Sustainable and Water Sensitive Sam Neua Town, Laos

Polycentric Approaches for the Management of Urban Waters

Baseline Study and Strategy Development

POLYURBAN WATERS

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ຕົວເມືອງຊຳເໜືອ ແລະ ການຫັນເປັນຕົວເມືອງຢູ່ແຂວງຫົວພັນ ແມ່ນກຳລັງມີການປ່ຽນແປງຢ່າງກ້ວາງຂວາງ ແລະ ໄວວາ ຍຸດທະສາດການຫັນປ່ຽນຂອງ ສປປ ລາວ ຈາກປະເທດທີ່ບໍ່ມີ "ຊາຍແດນຕິດກັບທະເລ" ມາເປັນ "ປະເທດເຊື່ອມໂຍງເຊື່ອມຈອດ" ແມ່ນເປີດໂອກາດສຳຄັນສຳລັບການພັດທະນາໃຫ້ຕົວເມືອງຊຳເໜືອ ຕາມທີ່ໄດ້ກຳນົດໄວ້ໃນແຜນພັດທະນາເສດຖະກິດ-ສັງຄົມ 05 ປີ (2020-2025) ຂອງເມືອງຊຳເໜືອ ນຳເອົາເປົ້າໝາຍການພັດທະນາແບບຍືນຍົງ ມາຜັນຂະຫຍາຍໃນຂັ້ນທ້ອງຖິ່ນ ແມ່ນຍຸດທະສາດທີ່ສຳຄັນເພື່ອຕອບໂຕ້ກັບສິ່ງທ້າທາຍ ຕໍ່ກັບຂະບວນການພັດທະນາຕົວເມືອງ ການຂະຫຍາຍຕົວຂອງຕົວເມືອງ ແມ່ນໄດ້ສ້າງສິ່ງທ້າທາຍຫຼາຍຢ່າງ ຕໍ່ກັບການວາງແຜນຜັງເມືອງທີ່ມີປະສິດທິພາບ ປະສິດທິຜົນ ແລະ ການຈັດຕັ້ງປະຕິບັດໃຫ້ໄດ້ຕາມແຜນ ວິທີການຄຸ້ມຄອງຊັບພະຍາກອນນ້ຳຂອງຕົວເມືອງແບບໃໝ່ ຕ້ອງຮັບປະກັນຄວາມໝັ້ນຄົງລະບົບນ້ຳຂອງຕົວເມືອງ ເຊິ່ງທັງໝົດນີ້, ແມ່ນສິ່ງຜົນໃຫ້ເມືອງຊຳເໜືອ ຕ້ອງປະເຊີນກັບການປ່ຽນແປງການນຳໃຊ້ທີ່ດິນຢ່າງໄວວາ ແລະ ຜົນກະທົບຕ່າງໆ ຈາກການປ່ຽນແປງດິນຟ້າອາກາດທີ່ເພີ່ມຂຶ້ນ.

ເພື່ອຮັບມືກັບການພັດທະນາ ແລະ ສິ່ງທ້າທາຍທີ່ຈະເກີດຂຶ້ນນັ້ນ ອຳນາດການປົກຄອງແຂວງຫົວພັນ ແລະ ເມືອງຊຳເໜືອ ພ້ອມດ້ວຍພະແນກການທີ່ກ່ຽວຂ້ອງ ທັງພາກລັດ-ເອກະຊົນ ແລະ ຊຸມຊົນ ຕ້ອງໄດ້ຊອກຫາວິທີການໃໝ່ທີ່ເໝາະສົມກັບພຸມສັນຖານຂອງຕົວເມືອງ ສຳລັບການພັດທະນາຕົວເມືອງແບບຍືນຍົງ ທີ່ແທດເໝາະຕາມຄວາມອາດສາມາດ, ທ່າແຮງ ແລະ ດ້ານການເງິນຂອງຕົນ.

ຂ້າພະເຈົ້າຂໍສະແດງຄວາມຊົມເຊີຍ ແລະ ເຫັນດີ ຕໍ່ກັບສິ່ງທີ່ຄົ້ນພົບ, ຄຳແນະນຳໃນເຊີງຍຸດທະສາດ ຈາກການສຶກສາຂັ້ນພື້ນຖານ ເຊິ່ງໄດ້ຍົກໃຫ້ເຫັນທ່າແຮງຍິ່ມຊ້ອນ ແລະ ພ້ອມດຽວກັນນັ້ນຍັງຍົກໃຫ້ເຫັນສິ່ງທ້າທ້າຍຕໍ່ກັບການຄຸ້ມຄອງນ້ຳແບບຮອບດ້ານ ໃນຂະບວນການພັດທະນາຂອງເມືອງຊຳເໜືອ ແລະ ອ່າງຮັບນ້ຳທັງໝົດ ໂດຍອີງໃສ່ການວິເຄາະດ້ານວິທະຍາສາດ ຜົນການສຶກສາດັ່ງກ່າວ, ໄດ້ກຳນົດຍຸດທະສາດ ແລະ ວິທີແກ້ໄຂເພື່ອຮັບປະກັນຄວາມໝັ້ນຄົງດ້ານນ້ຳ ແລະ ສ້າງຕົວເມືອງໃຫ້ມີຄວາມໝັ້ນຄົງ ທົນທານຕໍ່ຜົນກະທົບຈາກການປ່ຽນແປງດິນຟ້າອາກາດ ດັ່ງນັ້ນ, ບັນດາໜ່ວຍງານຕ່າງໆ ທາງພາກລັດ ຄວນນຳເອົາຜົນໄດ້ຮັບດັ່ງກ່າວ, ມາຜັນຂະຫຍາຍເພື່ອກຳນົດເປັນຍຸດທະສາດ ສຳລັບການພັດທະນາຕົວເມືອງ ທີ່ສາມາດຄຸ້ມຄອງນ້ຳໄດ້ແບບຮອບດ້ານ ແລະ ຍືນຍົງ ສຳລັບຕົວເມືອງຊຳເໜືອ ແລະ ຄຳແນະນຳເຫຼົ່ານີ້ ຄວນເປັນມາດຖານສຳລັບການວາງແຜນດ້ານການປະຕິບັດ ແລະ ດ້ານງົບປະມານສະເພາະ ສຳລັບການປະຕິບັດການວາງແຜນຜັງເມືອງຢ່າງມີຄວາມຕັ້ງໜ້າ.

ຂ້າພະເຈົ້າຂໍຂອບໃຈ ທາງໂຄງການ PolyUrbanWaters ໂດຍສະເພາະແມ່ນ BORDA, TU Berlin ແລະ ITT Cologne ແລະ ຂໍສະແດງຄວາມຂອບໃຈ ກະຊວງສຶກສາທິການ ແລະ ການຄົ້ນຄວ້າ ປະເທດເຢຍລະມັນ ທີ່ໄດ້ສະໜັບສະໜຸນທຶນ ສຳລັບການຮ່ວມມືລະຫວ່າງ ສປປ ລາວ ແລະ ປະເທດເຢຍລະມັນ ການສຶກສາຄັ້ງນີ້ ຈະໄດ້ປະຕິບັດຕາມມາດຕະການຍຸດທະສາດ ແລະ ການສ້າງຄວາມເຂັ້ມແຂງການຄຸ້ມຄອງນ້ຳແບບຮອບດ້ານ ສຳລັບຕົວເມືອງຊຳເໜືອ ເຊິ່ງໂດຍລວມແລ້ວ ແມ່ນເພື່ອປະກອບສ່ວນເຂົ້າໃນຂະບວນການສ້າງໃຫ້ເມືອງຊຳເໜືອກາຍເປັນເມືອງ "ສີຂຽວ, ສະອາດ ແລະ ສວຍງາມ"

ຮອງເຈົ້າແຂວງຫົວພັນ

Forward: Statement of vice-governor

Sam Neua Town and the urban settlements of Houaphan province are undergoing a rapid and profound change. The transformation of Lao PDR from a "land-locked" to a "land-linked country" opens up development opportunities for Sam Neua Town and the Sam Neua District as described in the Sam neua District Social 5 years Economic Development Plan 2020-2025. The localization of the Sustainable Development Goals is of strategic importance to meet the challenges of the urban development process. The growth of the urban area is associated with multiple challenges for effective urban planning and its implementation. New management approaches of urban water resources must ensure the water security of the city. And this is in the face of rapid land use change and the increasingly noticeable effects of climate change.

It is obvious that the Government in Houaphan Province and Sam Neua Town, together with the communities, social institutions and private sector actors, need to find new ways of sustainable urban development according to their institutional and financial capacities.

In this context, I welcome the findings and strategic recommendations of this baseline study. It highlights the potential, but also the challenges, for comprehensive water management in the context of the dynamic development process of Sam Neua Town and the entire basin. Based on comprehensive scientific analysis, these studies identify strategies and solutions for comprehensive water security for the town and increased resilience to climate change impacts. In this sense, the findings of government agencies should serve as a strategic document for sustainable, water-sensitive development of Sam Neua Town. These recommendations should serve as benchmarks for specific action planning and budgeting in the spirit of proactive urban planning.

I would like to thank the team of the PolyUrbanWaters project and here especially BORDA, TU Berlin and ITT Cologne for the preparation of this document. And here especially the German Ministry of Education Research to fund this collaboration between institutions of Lao PDR and Germany. This study will now be followed by measures to specify strategic measures and capacity development of a water-sensitive Sam Neua Town. These should contribute significantly to the realization of a "Green, Clean and Beautiful Sam Neua."

vice-governor of Huaphan Province

Executive Summary

The 9th National Socio-Economic Development Plan (NSEDP) 2021-2025 of the Lao People's Democratic Republic strongly focuses on the country's ability to move out of the "Least Development Country" status. The NSDEP seeks horizontal and vertical integration of the SDGs and the continued integration of the SDGs' indicators into local and sectoral strategies. SDG 6 "Clean Water and Sanitation", SDG 11 "Sustainable Cities and Communities" and SDG 13 "Climate Action" are prominent targets.

This study aims to help national and local stakeholders in Laos build a qualitative and quantitative understanding of "water" within urban development dynamics of Sam Neua town by providing information on current water resources, water use patterns, water-related risks, and existing and emerging challenges. Therefore, it gives support to localise SDGs in Sam Neua. It contextualizes existing and upcoming challenges to governance structures and management systems for urban water resources and water-related public services in the context of socio-economic development challenges, current and emerging public and private sector investment regimes, and key drivers, such as climate change. This provides a scientifically sound basis for informed decision-making with regard to the realization of the vision of a "green, clean, and beautiful Sam Neua" in the field of the management of urban waters.

The following is an overview of the key findings and derived from this, of strategic intervention areas for water-sensitive development of Sam Neua town.

Major findings

Urban development and urban planning practices

~ Located in Houaphan Province, the **population of Sam Neua town** was reported to be **18,187 in 2018**. Forecasts see the population of the urban area growing to more than **50,000 by 2045.** Major impulses for the development of the province and the town are expected from its integration into the Southeast Asian economic area, the development of the "North-Eastern Transport Corridor" of the Greater Mekong Sub-region and its proximity to Vietnam.

~ Sam Neua has been undergoing a **comprehensive transformation process** over the last decades. Instrumental to this have been its expansion trajectory into a provincial capital, combined with increasing development of public infrastructure, and the growth of settlements into previously agricultural areas. The **town centre of Sam Neua has also developed considerably** in recent years. The construction of administrative centres for the provincial and municipal governments, hotels, guest houses, commercial facilities, private houses, and a two-hundred-bed hospital, the expansion of urban infrastructures, such as bridges and river-widening and fortification of the banks of the Nam Xam River, the development of the central square and a large public "town park" and large fresh produce markets in the centre are the most obvious features of this development. There are also plans for two modern, large-scale hotels and a supermarket. Paradoxically vigorous construction activity occurred during the COVID-19 pandemic and associated restrictions.

~ If the development of the town centre follows the example of many other cities in Southeast Asia: the **urban area will increasingly become a higher-priced** urban area in the coming decades, where administration, business and residential facilities may be built on upper floors. Lower income groups would increasingly be displaced to more affordable areas, such as peri-urban locations, in urban extension areas or beyond.

~ So far, urban development in Sam Neua has followed the Urban Master Plan as well as planning and construction protocols to a limited extent. The **expansion of the urban area essentially follows the development of new road networks**, rather than a strategically, collectively created and implemented plan and planning process. Along these roads, agricultural land is being converted into building land. This process is followed by infrastructural network development (water supply, drainage, electricity, etc.), usually with a time lag. Building permits are granted retroactively.

~ The **unplanned urban growth and informal process** disables important options for the town as a whole. Moreover, individual villages fail

~ to develop themselves in a manner that meets the common interest, the interest of the communities and ultimately also the interest of new property owners to establish the essential urban planning parameters for sustainable community development.

~ Government agencies have recognised that this urban growth process and the associated water management challenges need to be given **a strategic urban planning framework to be adequately addressed.** These water challenges are likely to be exacerbated by **climate change impacts.** The town must be effectively and sustainably supplied with safe water and the water used must be adequately treated to avoid endangering public health and the environment. With **the land use changes** inside and outside the town, significant challenges arise to ensure water security and mitigate water-related vulnerabilities.

Natural characteristics for urban development and water resources

~ The **urban development and water management challenges** of Sam Neua **are largely conditioned by its topographical location**. The town and its rural and peri-urban areas are situated in relatively narrow valleys, limited in area and surrounded by steep, vegetated slopes. Urban growth is, to a large extent, limited occurring inwardly within these corridors.

~ Sam Neua is located in a **relatively small watershed** that has to supply the water resources needed for the entire town. The Nam Xam's total catchment area is 4750 km^2 within Lao, with 40% further catchment area within Viet Nam. 428.5 km2 are directly located upstream of Sam Neua. Particularly, with increasing demand for water and with dry periods lengthening because of climate change, the **limited discharge capacity of the watershed** may affect Sam Neua's long term water supply security.

~ Sam Neua itself has a **rich hydrological system**. The Nam Xam River valley collects the waters from the altitudes above 2000m on the Houa Mountain. Several different streams discharge their water to the Nam Xam water body. Forests along the hillside and Sam Neua's extensive blue-green infrastructure, such as paddy fields, riparian wetlands, fish ponds, etc., provide important services for water supply, the overall water cycle and the attractiveness of the town. With its function as a water buffer and water storage, these ecosystems contribute significantly to water safety, to the resilience to heavy rainfall events and to the mitigation of water scarcity.

~ Although it is difficult to predict the specific impacts of **climate change** for Sam Neua itself, it must be assumed that there will be an **increased frequency of heavy rainfall events** and **prolonged dry periods**. This can have a significant impact on water resources and can contribute to a significantly increased vulnerability of the town. In Sam Neua town, for example, water shortages can occur during dry periods, and during rainy periods there can be a considerably higher run-off of stormwater, resulting in significant flooding events.

Vulnerabilities induced by land use changes

~ Today, Sam Neua's growth is determined by an **accelerating conversion of agricultural land** into settlement areas. If the forecasts for urban growth and population development prove accurate, it can be assumed that **by 2045** the valley will be almost exclusively dominated **by urban land use** patterns, i.e. urban settlement areas.

~ Sam Neua's **natural surroundings offer considerable ecosystem services and nature-based solutions** that provide significant benefits to the water security of the town. Beyond their importance for the water balance, they contribute significantly to the mitigation of flood and drought vulnerabilities. The current significant and dynamic land use changes in the watershed are expected to contribute significantly to the weakening of Sam Neua's water security. The extensive conversion of forest areas into agricultural land in the catchment area and the conversion of agricultural land into settlement areas in surrounding valleys has already had a considerable influence on the water run-off regime of the town. It is apparent that the comprehensive water security of Sam Neua is difficult to achieve without sustainable land management in the watershed. This demonstrates the town's strategic interest in adequate measures to protect the water catchment.

~ As urbanisation and the associated increase in sealed surfaces and artificial drainage accelerates, the **hydrological system comes under increasing pressure**, posing particular challenges for urban planning, infrastructure development and urban water management. Overall, the increasingly high degree of land sealing (typically with concrete) and the associated loss of infiltration areas can create a **'tub' effect in** which run-off water flows increasingly unchecked to the stormwater drainage network (where provided) and surface waters. The approximate sealed area in the settlement area of Sam Neua grew from 280 ha in 2011 to 491 ha in 2021. The loss of rice fields reduces water retention, accelerates the water run-off and contributes to the increased flood vulnerability of Sam Neua and its peri-urban transition zones, especially during heavy rainfall events.

~ The **floods that hit the urban area in 2018** could thus become a **"new normal"** or continue to intensify as an effect of the urban development process and climate change. Targeted measures taken to protect the town, particularly widening of the Nam Xam River in the central town area, have been insufficient in the face of significant rainfall events.

~ The **limited land availability** favors construction activities close to the steep slopes and into the slopes themselves (cut and fill practices). These activities are rarely carried out on the basis of qualified geological assessments and are barely supported by static securing measures on the slopes. Alterations of slope structure can lead to destabilisation with consequent landslides and thus endanger buildings and lives. The change in vegetation on and along the slopes and water erosion, which is exacerbated by heavy rainfall, can contribute significantly to **further destabilisation in the short, medium and long terms**.

~ At the same time, due to the scarcity of land, buildings are increasingly being built in **zones at risk of flooding**. These risk zones are expected to expand in the future as the risk of flooding increases. This results in a significant threat to residents and economic assets.

Green urban development

~ In its vision, the town has defined **“green”** as a strategic element of urban development. In the course of implementation, parks were created and, above all, trees were planted. However, the analysis presented here shows that **“green” infrastructure and nature-based solutions** perform an essential function in terms of **water security, ecosystem services and livability of the town:** good water quantity and quality, reduced flood and climate change vulnerability, pleasant local climate and attractive habitats. But the existing green infrastructure and nature-based solutions are under increasing pressure.

~ The importance of dimensions of urban development and the use of nature-based solutions are increasingly recognised by administrative staff and residents. Despite their crucial strategic importance for the development of the town as a whole, however, they have **not yet been systematically integrated into urban development and budget planning**.

~ A key objective for urban development is the development of the tourism sector. The **attractiveness of Sam Neua** for tourists is mainly due to its **environment and green spaces**. The overall impression of Sam Neua is changing due to the dynamic change in land use patterns and the loss of large areas of paddy fields. As tourist areas in Vietnam show, this mix between agricultural land, as in paddy fields in the case of Vietnam, and an attractive urban area is essential for the development of tourism destinations. This shows a need for urban development planning that especially sets guidelines for the development of Sam Neua within the framework of a green urban design.

Water supply

~ In the last two decades, Sam Neua has **succeeded in considerably improving and securing the water supply** for large parts of its population. Until the late 1990s households relied on rainwater collection and individual extraction of water from surface waters bodies. The current water supply system provides 90 % of urban Sam Neua's population with raw water, while the remainder of the population especially in the extension area use covered wells to pump groundwater, standpipes, or river water. The current water demand ranges between 2,900 m^3 /day to 3,300 m^3 /day forecasted at 11,300 m^3 /day for 2041.

~ Despite the expansion of the production capacities for piped water, during **annual droughts**, supplying adequate water to the town is becoming an increasingly challenging task given **population growth**, **changing water consumption patterns** and **land use changes**. With **climate change**, a safe year-round supply of tap water may become even more difficult. The majority of households cover their drinking water needs through bottled water locally produced by five different companies and distributed to households via a van delivery service, which indicates quality or trust issues with piped water and water from wells.

Wastewater management

~ Although limited robust data is available, it is evident that Sam Neua is facing an overall deterioration in the quality of its surface and groundwater. The **water consumed** is typically **inadequately treated** and discharged into the **environment and water bodies**. Sam Neua has no sewage system, technically inadequate septic tanks and soak pits are widespread, and sludge is rarely, if ever, pumped out and when sludge is removed, it is inadequately disposed of.

~ In addition to the increasing E-coli load, discharges of **waste oils, chemicals, over-fertilization and other toxic substances** pollute the water bodies.

Waste management

~ Households, hotels, public institutions, marketplaces, shops, work shops and other small and medium enterprises generate increasing quantities of municipal waste, some of which is highly toxic. The quantity of household and other forms of waste will increase with a dynamic urbanization process, resulting in an increasing quantity and variety of waste in future, such as from the newly built hospital. Although the town has managed to **establish a waste collection system** in recent years and has also started to separate waste for recycling (valuables such as plastic bottles and metal cans), the waste generation and overall inadequate waste management system poses significant **risks to public health, ecosystems and for tourism development**.

~ The local government has recognised the threat to health, environment and water bodies posed by the dumpsite at Na Ang village. Prospections have been undertaken for the construction of sanitary landfills that will enable the closure of the dumpsite and other wild dumpsites curtailing their highly harmful emissions to soil, air, and water. So far, there is no funding for such a facility.

Urban planning governance

~ Continuing difficulties in the **implementation of the Urban Master Plan** for urban development from 1997, and its updated version from 2011, are prime examples of the overall challenges faced by the local government´s attempts to administer Sam Neua´s urban development. Translating national strategies and policies into an implementable urban development plan that is applied, respected, and complied with by all relevant stakeholders is vital. This is especially the case in the challenge to localise the SDGs in the town. To move forward, Sam Neua is challenged to develop governance structures that can play a **proactive** role in the urban transformation process and to bring Sam Neua's vision to reality.

~ National regulations increasingly emphasize the importance of **involving relevant stakeholders** in decision-making processes for sustainable urban development. In practice, however, this does not yet take place to a **sufficient extent**.

~ The local government has recognized that the **management of urban water resources** and the provision of basic water-related services require a more **comprehensive urban development and infrastructure development approach**. However, the local government has **insufficient capacities** to apply the nationally adopted guidelines and manuals for effective planning. There is a lack of specific expertise, material resources, and data or data management systems that would allow for the continuous updating of planning processes and the monitoring of proper implementation.

~ The objectives stated in the Urban Planning Manual for Sam Neua require **intersectoral cooperation** between the different local government departments. Although this is already rudimentarily defined in the respective guidelines and established working practices, clearly defined standard processes and cooperation formats are needed, especially with regard to dealing with the challenges discussed here.

~ The **loopholes** for circumventing guidelines and regulations are considerable. While planning and building controls only apply to developments that have sought a building permit; it appears there are developments that avoid the permit/building approval process and are, therefore, not subject to building approvals and controls. Defined processes and regulations are not sufficiently enforced and monitored.

Strategic intervention areas for a "green, clean and beautiful Sam Neua"

Vision and its translation into practice: "Water" is cross-cutting to realize Sam Neua's vision. Accordingly, it should be addressed as a cross-cutting issue in urban development planning, infrastructure planning, financial planning, and budgeting. The results of the study presented here indicate key areas of action for how this vision can be translated into practice. The findings show that "classical" development of water-related infrastructure, such as the expansion of water supply systems, should go hand-in-hand with approaches to integrated, cross-sector infrastructure development. Effective stormwater and drainage management with its components of grey and green infrastructure development is one example. This requires an adequate level of cross-sectoral coordination within the town and provincial administrations and the involvement of relevant stakeholders. Here, the management level is required to be able to organise such processes effectively.

Vision building and green and water-sensitive town development: Sam Neua is recommended to expand the definition of "green" in its vision. Although the planting of trees in Sam Neua can make a significant contribution to beautifying Sam Neua, "green" should be understood as a cross-cutting issue for sustainable and water-sensitive urban development. Green infrastructure and nature-based solutions are essential for maintaining a pleasant local climate even during dry seasons, for sustainable management of water bodies and ecosystems, for protecting the urban area from flooding, for attractive development of the Town Center, for the expansion areas, and for community development.

Green and water sensitive urban development of the Town Center: The "green" development of the town center is certainly of crucial importance for the realisation of the vision. A water-sensitive development for this inner-urban space should avoid the complete sealing of surfaces through the design of green spaces and the development of infiltration areas on public and private premises as an important element of comprehensive flood protection. The development of vegetation zones, for example along the floodplains and riverbanks and in the inner urban area, can make a significant contribution to maintaining a pleasant local climate, can mitigate flood risks and contribute to an attractive living space for residents and tourists. The greening of public and private buildings and roofs can also contribute to the retention of rainwater runoff and improve the local climate. Strong participation of local stakeholders in planning and implementation of respective measures will be key for effective development and sustainable management of these areas.

Green and water-sensitive urban development of expansion areas and community development in extension areas: Public infrastructure in these areas should be planned and implemented proactively before largely uncontrolled construction activity decisively restricts the scope of action for any sustainable development. At the community level, for example, important questions should be addressed, such as which areas should be reserved for community use (public spaces, schools, sports fields, shops, etc.)? How riparian areas and green areas of public interest can be developed and managed so that they contribute to flood resilience for the villages and the overall town? Strong community involvement is essential for the sustainable development of these villages and areas. The ownership, knowledge and practical experience of the local population is particularly important for the development, management and effective operation of green infrastructure and nature-based solutions.

Scenario
Water-Sensitive Town

Disaster resilient construction and settlement development: To counter the increasing risks of inundation of settlements and mudslides, granting of building permits should follow internationally practiced guidelines and standards. No construction activities should be possible on already or potentially unstable slopes respectively when structural safety measures or erosion protection cannot be guaranteed. The construction of buildings in existing and potentially flood-prone zones should be prohibited. Even facilities built on stilts cannot withstand the violent run-off during extreme weather events in the Sam Neua valley. Comprehensive mapping should be done to indicate risk zones. Urban planning should already consider that these risk zones will most likely expand significantly in the course of expected changes in land use and climate change impacts.

Flood and stormwater management: The predicted intensifying and uncontrolled run-off of surface waters, especially during heavy rain events, will only be countered effectively by a combination of grey and green infrastructure development (including nature-based solutions). Overall, a 'tub' or 'gully' effect in the overall valley should be prevented, in which surface water increasingly runs off unhindered. The systematic combination of stormwater retention structures (such as water retention basins), drainage systems, restriction of the sealing of surfaces, solid waste management, and the development and sustainable management of green infrastructures is crucial for comprehensive flood protection.

Water catchment management: Increasing flood vulnerability should be understood in terms of the chain of causes or in the interaction of different and mutually reinforcing factors. Sustainable land uses (forestry, agriculture) in the upper part of the catchment are as much a part of flood mitigation as the prevention of uncontrolled sealing of land in the peri-urban and urban areas. An Integrated River Basin Management approach including a 5-year Nam Xam River Basin Management Action Plan may be instrumental to address adequately the challenges in the overall water catchment area. Such an approach also takes into account the challenge that the management of urban waters requires cooperation beyond the city boundaries and intersectoral cooperation at the provincial level.

Water supply: The sustainable and effective supply of the town with **sufficient and good quality water** will depend to a large extent on healthy ecosystems in the entire water catchment area, including the peri-urban area. The sustainable management of these ecosystems is essential for their protection. The systematic introduction of **water safety plans** and the **establishment of a water monitoring system** can make a significant contribution to water supply security. In addition to improving the technical performance of the system, i.e. **reducing technical losses**, measures such as the **development of water harvesting structures** on private and public premises and the efficient use of tap water (water conservation) should be taken.

Wastewater management: In accordance with its financial and institutional capacities, Sam Neua should follow an approach of progressive implementation. The compulsory construction of **improved septic tanks** and mandatory **regular desludging,** the **development of Decentralised Wastewater Treatment System (DEWATS) clusters** and their effective operation, and the construction of a **Sludge Treatment Plant** should be an essential basis for the treatment of domestic and institutional wastewater for the foreseeable future. A sludge management system should be established that allows for regular emptying of on-site facilities and proper treatment at a sludge management facility. This includes the development of a robust operating system that allows service providers to operate an efficient business model. In the same way, appropriate law enforcement and monitoring capacities on the part of local government are crucial for effective wastewater and sludge management. Facilities, such as hospitals, may need more sophisticated technical wastewater treatment solutions. Furthermore, adequate treatment and collection of **waste oils** and **chemicals** is as much a part of comprehensive water protection as improving fertiliser management.

Waste management: The development or financing of a sanitary landfill is currently the most important factor for effective waste management. However, such a **sanitary landfill** would not solve the town's waste problems alone. The waste should be separated at its source (e.g. at the household level) and treated in different management streams to prevent rapid exhaustion of disposal capacities. Waste with **high organic content** (kitchen waste, etc.) should be composted and capacities for the management of recyclable materials should be strengthened. For this, special awareness-building measures should be carried out among polluters (households, businesses, and institutions). **Toxic/chemical waste**, such as **medical waste** generated at the hospital, should be collected, separated and given adequate treatment outside Sam Neua as an incineration plant will be difficult to finance in the foreseeable future. Nevertheless, the legal basis for this is still lacking.

Public awareness, stakeholder participation and community development: Sam Neua's water-related challenges go beyond simple technical infrastructure solutions and the associated development tasks. To have a greater sustainable impact and with general agreement of the importance of schools and students as "change agents" for raising the public's awareness of thoughtful and effective water use, Sam Neua's tradition of public neighbourhood clean-up campaigns needs to be leveraged. Broadly speaking, public awareness campaigns are essential for the comprehensive dissemination of solutions, such as water harvesting and wastewater management measures. This is especially true for the successful implementation of strategies that include waste separation or community-based management of riparian zones. Participatory planning processes are essential for the development of water-sensitive urban areas, neighborhoods and communities. The targeted sensitization of the relevant stakeholder groups with specific information as well as consistent leadership and accountability, in particular, are essential for the identification and implementation of appropriate interventions acceptable to the public.

Planning and Financing: A systematic and targeted planning process approach tailored to Sam Neua's context is essential and should be specified through the identification of strategic measures and their implementation within the framework of an action planning process. A large number of the activities will need to be funded through the public budget and so must be included in the budget planning process. However, given the constraints on public budgets, complementary financing is essential. Here, existing and emerging lines of climate finance can open up new opportunities for action. The necessary systematic, integrated planning of measures that reduce the vulnerabilities to flooding events in the course of adaptation to climate change could, for example, be examined under financing lines, such as the Green Climate Fund. Similar funding lines could be used for green-house gas mitigation measures that include sanitary landfills, composting facilities, or food processing wastewater treatment systems (coffee, noodles, etc.) based on renewable energy. Furthermore, investors in the tourism industry should be encouraged and motivated to develop green, water-sensitive hotels, for example. Essential to such water-sensitive urban development is the mobilization of residents' own contributions, and through awareness campaigns, the public should be informed, for instance, of the benefits of developing infiltration on private areas and acquiring rainwater collection systems.

List of Abbreviations and Acronyms

ADB	Asian Development Bank
AIT	Asian Institute of Technology
BOD	Biological oxygen demand
BORDA	Bremen Overseas Research and Development Association
CBDRR	Community Based Disaster Risk Reduction
CDE	Centre for Development and Environment
COD	Chemical oxygen demand
DEWATS	Decentralized Wastewater Treatment Systems
DHUP	Department of Housing and Urban Planning
DMH	Laos Department of Meteorology and Hydrology
DoI	Department of Irrigation
DoIH	The Department of Industry and Handicraft
DoNRE	Department of Natural Resources and Environment
DPWT	Division of Public Works and Transport
DWS	Department of Water Supply
EIA	Environmental Impact Assessment Report
ENSO	Niño–Southern Oscillation
GDP	Gross domestic product
GMS	Greater Mekong Subregion
HAGL	Hoang Anh Gia Lai Group
IMF	International Monetary Fund
IPCC	Intergovernmental Panel on Climate Change
ITT	The Institute for Technology and Resources Management in the Tropics and Subtropics
IWA	International Water Association
Lao PDR	Lao People's Democratic Republic
LSB	Lao Statistical Bureau
MDG	Millennium Development Goals
MLSW	The Ministry of Labor and Social Welfare

MoF	Mnisitry of Finance
MoH	Ministry of Health
MoIC	Ministry of Industry and Commerce
MoNRE	The Ministry of Natural Resources and the Environment
MPI	The Ministry of Planning and Investment
MPWT	The Ministry of Public Works and Transport
NBCA	National Biodiversity Protected Area
NEM	New Economic Mechanism
NPNL	Nam Papa Nakhone Luan
NRES	Natural Resources and Environment Strategy
NSEDP	National Socio-Economic Development Plan
OPWT	Office of Public Works and Transport
PCD	Pollution Control Department
PDR	People's Democratic Republic
PNP HPAN	Provincial Nam Papa
PWT	Public Works and Transport Training Institute
SDG	Sustainable Development Goals
SEDP	Social Economic Development Plan
SEZ	Special Economic Zone
SHUP	Sector of Housing
TSS	Total suspended solids
TUB	Technical University of Berlin
UCRSEA	Urban Climate Resilience in Southeast Asia
UDAA	Urban Development Administration Authority
VCOMS	Vientiane City Office for Management and Services (formerly VUDAA)
WEPA	Water Environment Partnership in Asia

Terminology and Definitions

Adaptive capacity: The combination of the strengths, attributes, and resources available to an individual, community, society, or organization that can be used to prepare for and undertake actions to reduce adverse impacts, moderate harm, or exploit beneficial opportunities (IPCC, 2012).

Baseline/reference: The baseline (or reference) is the state against which change is measured. It might be a 'current baseline,' in which case it represents observable, present-day conditions. It might also be a 'future baseline,' which is a projected future set of conditions excluding the driving factor of interest. Alternative interpretations of the reference conditions can give rise to multiple baselines (IPCC, 2012).

Biochemical Oxygen Demand (BOD): describes how much oxygen is required for the oxidisation of matter, which can be oxidised biologically with the help of bacteria (Ulrich et al., 2009).

Blue Infrastructure: The European Commission stated that blue infrastructure is understood as a strategically planned and intensively managed system of natural, seminatural and man-made water-based features such as coastal areas, rivers, lakes, wetlands but also designed elements such as artificial channels, ponds, water reservoirs, retention basins and tanks as well as urban waste water networks.

Catchment: An area that collects and drains precipitation (IPCC, 2012).

Chemical Oxygen Demand (COD): is the most common parameter for measuring organic pollution. It describes how much oxygen is required to oxidise all organic and inorganic matter found in water (Ulrich et al., 2009).

Climate change: A change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer (IPCC, 2012).

Climate: in a narrow sense is usually defined as the average weather, or more rigorously, as the statistical description in terms of the mean and variability of relevant quantities over a period of time ranging from months to thousands or millions of years. The classical period for averaging these variables is 30 years, as defined by the World Meteorological Organization. The relevant quantities are most often surface variables such as temperature, precipitation, and wind. Climate in a wider sense is the state, including a statistical description, of the climate system. In various chapters in this report different averaging periods, such as a period of 20 years, are also used. (IPCC, 2012).

Disaster management: Social processes for designing, implementing, and evaluating strategies, policies, and measures that promote and improve disaster preparedness, response, and recovery practices at different organizational and societal levels (IPCC, 2012).

Disaster risk: The likelihood over a specified time period of severe alterations in the normal functioning of a community or a society due to hazardous physical events interacting with vulnerable social conditions, leading to widespread adverse human, material, economic, or environmental effects that require immediate emergency response to satisfy critical human needs and that may require external support for recovery (IPCC, 2012).

Drought: A period of abnormally dry weather long enough to cause a serious hydrological imbalance (IPCC, 2012).

Evapotranspiration: In reference to evaporation (E) from soil, plant surfaces and water bodies and the transpiration (T) through plant canopies. The term is useful in regards agriculture where the actual evapotranspiration relates to the Crop Water Requirements.

Exposure: The situation of people, infrastructure, housing, production capacities and other tangible human assets located in hazard-prone areas ([UNDRR] United Nations Office for Disaster Risk Reduction, 2020).

Flood: The overflowing of the normal confines of a stream or other body of water, or the accumulation of water over areas that are not normally submerged. Floods include river (fluvial) floods, flash floods, urban floods, pluvial floods, sewer floods, coastal floods, and glacial lake outburst floods (IPCC, 2012).

Green Infrastructure: Strategically planned and intensively managed systems of natural, seminatural and man-made land-based features such as terrestrial protected areas, field margins in intensive agricultural land, ecoducts and tunnels for animals, parks and green roofs in cities (Lucius et .al, 2011).

Grey Infrastructure: This term is often used to oppose what is called “Green-blue (or natural) infrastructure”, it refers to any hard structure or traditional engineering solutions (UNEP, 2019).

Greywater: is the total volume of water generated from washing food, clothes and dishware, as well as from bathing, but not from toilets. It may contain traces of excreta (e.g., from washing diapers) and, therefore, also pathogens. Greywater accounts for approximately 65 % of the wastewater produced in households with flush toilets (IWA, 2016).

Hazard: A process, phenomenon or human activity that may cause loss of life, injury or other health impacts, property damage, social and economic disruption or environmental degradation ([UNDRR] United Nations Office for Disaster Risk Reduction, 2020).

Hydrological/water cycle: The cycle in which water evaporates from the oceans and the land surface, is carried over the Earth in atmospheric circulation as water vapor, condenses to form clouds, precipitates again as rain or snow, is intercepted by trees and vegetation, provides runoff on the land surface, infiltrates into soils, recharges groundwater, and/or discharges into streams and flows out into the oceans, and ultimately evaporates again from the oceans or land surface. The various systems involved in the hydrological cycle are usually referred to as hydrological systems (IPCC, 2012).

Integrated Water Resource Management: Is a process which promotes the coordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems (GWP, 2011).

Land use and land use change: Land use refers to the total of arrangements, activities, and inputs undertaken in a certain land cover type (a set of human actions). The term land use is also used in the sense of the social and economic purposes for which land is managed (e.g., grazing, timber extraction, and conservation). Land use change refers to a change in the use or management of land by humans, which may lead to a change in land cover (IPCC, 2012).

Landslide: A mass of material that has moved downhill by gravity, often assisted by water when the material is saturated. The movement of soil, rock, or debris down a slope can occur rapidly, or may involve slow, gradualfailure (IPCC, 2012).

Nature-based solutions (NbS): have been defined as "actions to protect, sustainably manage, and restore natural or modified ecosystems, that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits" (IUCN, 2016). NBS are not intended to replace grey infrastructure and technical solutions but rather to integrate with them in order to form resilient combinations that adapt to complex systems and changing environments (Haase, 2015), (Bai, 2018) recommends applying a "kaleidoscope" approach when working with NBS. An approach that connects to the principles of urban ecology and acknowledges existing settings (governance, social systems & infrastructure) while initiating truly creative interconnections that go beyond a grey, blue or green focus.

Polycentric management of urban waters (PUW): The concept of PUW considers the challenges for urban areas and settlements to include "water" as a cross-cutting issue requiring cross-sectoral solutions. PUW brings together security of supply of water-related services (water supply, waste water and waste management, flood management, etc.), resilience to the impacts of climate change, and the creation of livable and inclusive urban spaces in an integrated approach to sustainable water resource management (IWRM) and participatory urban development planning. The solutions are developed and implemented according to the specific natural and socio-economic characteristics of the respective urban areas, the regulatory frameworks, and the financial and institutional capacities of the towns and local stakeholders.

Progressive Implementation: This principle follows the Agenda 21 of the United Nations Conference on Environment & Development Rio de Janerio, 1992. Infrastructure development should be guided in accordance with local capacities and the local context in order to ensure sustainable maintenance and operation (UNSD, 1992).

Resilience: The capacity of social, economic and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity and structure, while also maintaining the capacity for adaptation, learning, and transformation Progressive Implementation (Sutton et al., 2011). The ability of a system and its component parts to anticipate, absorb, accommodate, or recover from the effects of a hazardous event in a timely and efficient manner, including through ensuring the preservation, restoration, or improvement of its essential basic structures and functions (IPCC, 2012).

Risk: Potential for adverse consequences for human or ecological systems as a result from dynamic interactions between hazards, exposure and vulnerability of the affected human or ecological system (IPCC, 2022).

Runoff: That part of precipitation that does not evaporate and is not transpired, but flows through the ground or over the ground surface and returns to bodies of water (IPCC, 2022).

Urban Heat Island: The relative warmth of a city compared with surrounding rural areas, associated with changes in runoff, the concrete jungle effects on heat retention, changes in surface albedo, changes in pollution and aerosols, and so on (IPCC, 2012).

Urban Waters: is a concept of sustainable urban water management. Urban waters within the city (including reservoir and aquifer water, desalinated water, recycled water and stormwater) are managed in a way that maximises the achievement of urban liveability outcomes and resilience to unexpected social, economic or bio-physical shocks (IWA, 2016).

Vulnerability: The degree to which a system is susceptible to, or unable to cope with, adverse effects of. climate change, including climate variability and extremes (IPCC, 2022). The characteristics and circumstances of a community, system, or asset that make it susceptible to the damaging effects of a hazard (UNEP, 2019).

Wastewater: is the mixture of Urine, Faeces and Flushwater along with Anal Cleansing Water (if water is used for cleansing) and/or Dry Cleansing Materials). Wastewater contains the pathogens of Faeces and the nutrients of Urine that are diluted in the Flush-water (IWA, 2016).

Water Security: is defined here as the capacity of a population to safeguard sustainable access to adequate quantities of acceptable quality water for sustaining livelihoods, human well-being, and socio-economic development, for ensuring protection against water-borne pollution and water-related disasters, and for preserving ecosystems in a climate of peace and political stability (UNU-INWEH, 2013).

Water Sensitive Urban Development: In helping cities transition to ecologically based systems that also address climate change impacts, urbanization, and population growth, the Water Sensitive Urban Design (WSUD) approach has been evolving and implemented in existing and new developments around the world since the 1990s, including Asia through the use of various tools and technical solutions that integrate the natural elements of water, plants and soil while maintaining the natural water cycle. With new designs for building suburbs mitigating water discharge from heavy rainfalls by absorbing, storing and using stormwater runoff (rather than losing runoff to direct drainage from impervious surfaces to waterways), WSUD can deliver multiple benefits including increased, better quality water supply, stormwater quality improvements, flood control, landscape amenity, healthy living environments, and ecosystem health. Essentially, WSUD emphasises alternative urban water supplies that reduce the stress on a town's water treatment facilities, re-naturalize water courses and associated riparian areas, and install vegetative technologies that create attractive urban streets while providing much-improved stormwater quality (Sharma et al., 2018). Indirectly, such improvements to the urban living environment can increase land values and expand tourism and other business opportunities (IWA, 2016).

Introduction

In the second Voluntary National Review (VNR) 2021, the Government of Lao People's Democratic Republic states its strong commitment to the implementation of the 2030 Agenda for Sustainable Development. On a regional level, Laos is to be transformed from a “land-locked country” to a “land-linked country” by integrating it into the Southeast Asian economic area.

The Government acknowledges that the localization of the SDGs remains a challenging task despite many notable achievements. The 9th National Socio-Economic Development Plan (NSEDP) 2021–2025 is strongly focused on the country's ability to move out of the “Least Development Country” status. The NSDEP seeks horizontal and vertical integration of the SDGs and the continued integration of the SDGs’ indicators into local and sectoral strategies. SDG 6 “Clean Water and Sanitation”, SDG 11 “Sustainable Cities and Communities” and SDG 13 “Climate Action” are prominent targets.

The aim of the “PolyUrbanWaters” Project, funded by the German Federal Ministry of Education and Research (BMBF), is that “polycentric approaches to urban water resource management contribute to the water-sensitive transformation of secondary and tertiary cities in SEA towards resilient, inclusive and liveable urban areas”.

The project has been invited by the Department of Housing and Urban Planning of the Ministry of Public Works and Transport (MPWT) of the Lao People's Democratic Republic and the local government of Sam Neua to contribute to the localization of the SDGs and to the realization of its vision of a “green, clean and beautiful Sam Neua” through the sustainable management of urban waters.

The MPWT emphases that “PolyUrbanWaters” contributes to its urban planning objective of “One city – One Plan” for Sam Neua town, in which there is a transition away from ideal-typical but ineffective approaches to effective urban planning approaches for specific conditions and capacities. Such approaches should identify strategic fields of action for urban development and realistic options for their implementation.

The study presented here responds to the interest of the national and local government in strengthening the information base and capacity for informed decision-making. The study was developed in collaboration between stakeholders from Lao PDR and an international research team. It not only comprehensively identifies the challenges and opportunities of sustainable water management in the context of Sam Neua's urban development but is the starting point for strategy development and capacity building processes supported by “PolyUrbanWaters” until 2024.

The study provides an overview of the characteristics of the urban environment followed by a detailed assessment of the major water challenge findings in Sam Neua in the context of a dynamic urban development process. To address these challenges and the town's development goals, recommendations for action are derived. Each section details the specific natural, water-related, urban planning and regulatory characteristics of the urban development context of Sam Neua as well as solution pathways.

As for Sam Neua town, similar processes are being carried out simultaneously in the PolyUrbanWaters cities of Sleman, Indonesia and Kratie, Cambodia. The results will be made available to the interested public in a series of publications.

March 2023

POLYURBAN WATERS

Background and Objectives of the Study

PolyUrbanWaters, implemented from 2019 to 2024, is a research project funded by the German Federal Ministry of Education and Research (BMBF). The project consortium consists of academic institutions, municipalities, local and national government agencies, civil society and private-sector stakeholders from Indonesia, Cambodia, Laos, Thailand, Vietnam and Germany.

The PolyUrbanWaters project aims to generate comprehensive scientific knowledge that helps to develop practice-relevant strategic planning models for fast-growing cities and peri-urban areas in Southeast Asia, enabling them to implement polycentric approaches for water-sensitive urban development (Figure 1).

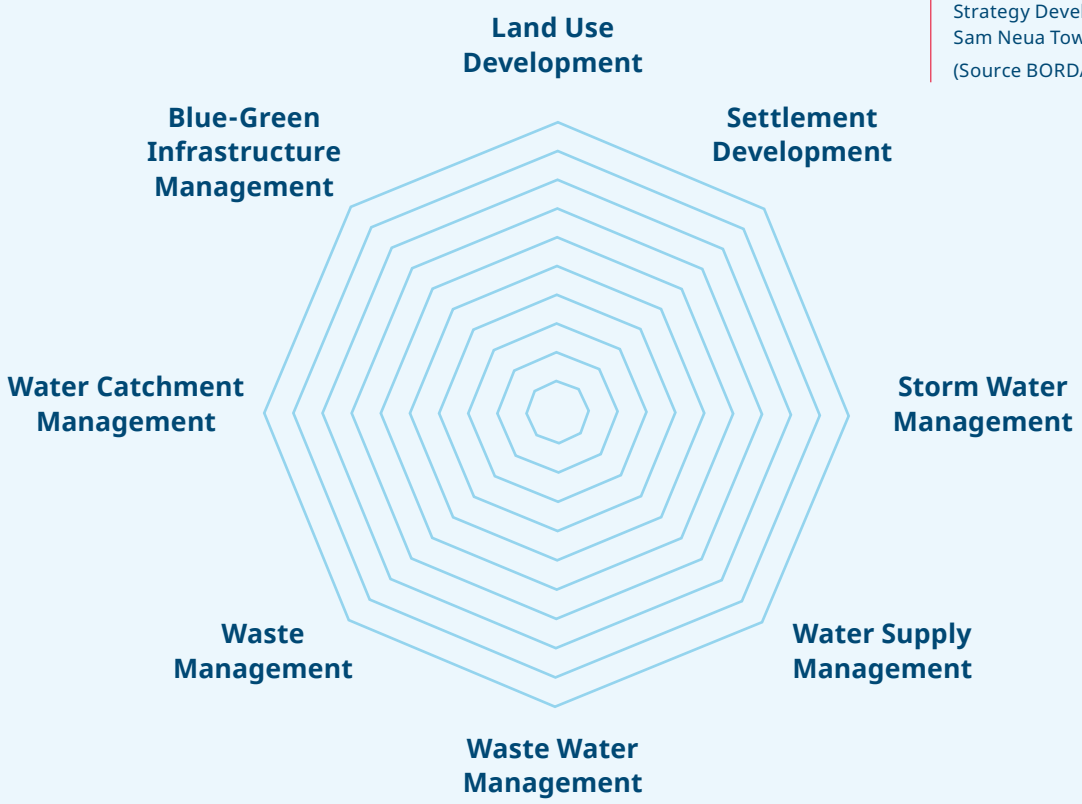


Figure 1. Dimensions of Baseline Study and Strategy Development, Sam Neua Town (Source BORDA, 2022)

PolyUrbanWaters gives cities and towns in Southeast Asia support on different levels:

- Advice for SDG-oriented, strategic, cross-sectoral, water-sensitive urban development;
- Generation of evidence-based knowledge for informed decision-making;
- Identification of strategic "entry points" for implementation of polycentric planning;
- Capacity building for strategic project management and facilitation of co-production procedures at the local level to support communities, the public and private sectors, and academia;
- Facilitation of access to cutting-edge academic knowledge about the polycentric management of urban waters.

This study aims to support national and local stakeholders in Laos and respectively in Sam Neua:

- build a qualitative and quantitative understanding of "water" within urban development dynamics by providing information on current water resources, water use patterns, water-related vulnerabilities and existing and emerging water challenges for Sam Neua town;
- to elaborate a comprehensive understanding of the water cycle within the natural context of the town, the context of the urban development dynamics and urban spaces;
- to contextualize the already existing and the upcoming challenges for governance structures and management systems for urban water resources and water-related public services in the context of socio-economic development challenges, current and emerging investment regimes of the public and private sectors and main drivers, such as climate change;
- to elaborate a robust information base for informed decision-making for the future water sensitive development of Sam Neua town.

Methodology

The findings presented in this report are the result of a research process initiated in 2019. These findings present essential parameters for the management of water resources and their economic, social and ecological impacts in the context of Sam Neua town's development dynamics.

The conceptual framework of the study is based on the Driving-Force/Pressure/State/Impact/Response method. This framework allows a well-structured analysis of natural, social and economic information in the context of an urban transformation process (Figure 2).

Driving forces such as demographic, economic, social and climate change induced causes of urban transformation may translate into **pressure** on water and natural resources, such as higher water demand. The **state** of water resources is captured by information on water quantity and quality and overuse of natural water resources that may have an **impact** on public health and ecosystems. Improved land use planning and infrastructure development may be appropriate **responses** to mitigate pressures and to achieve development targets.

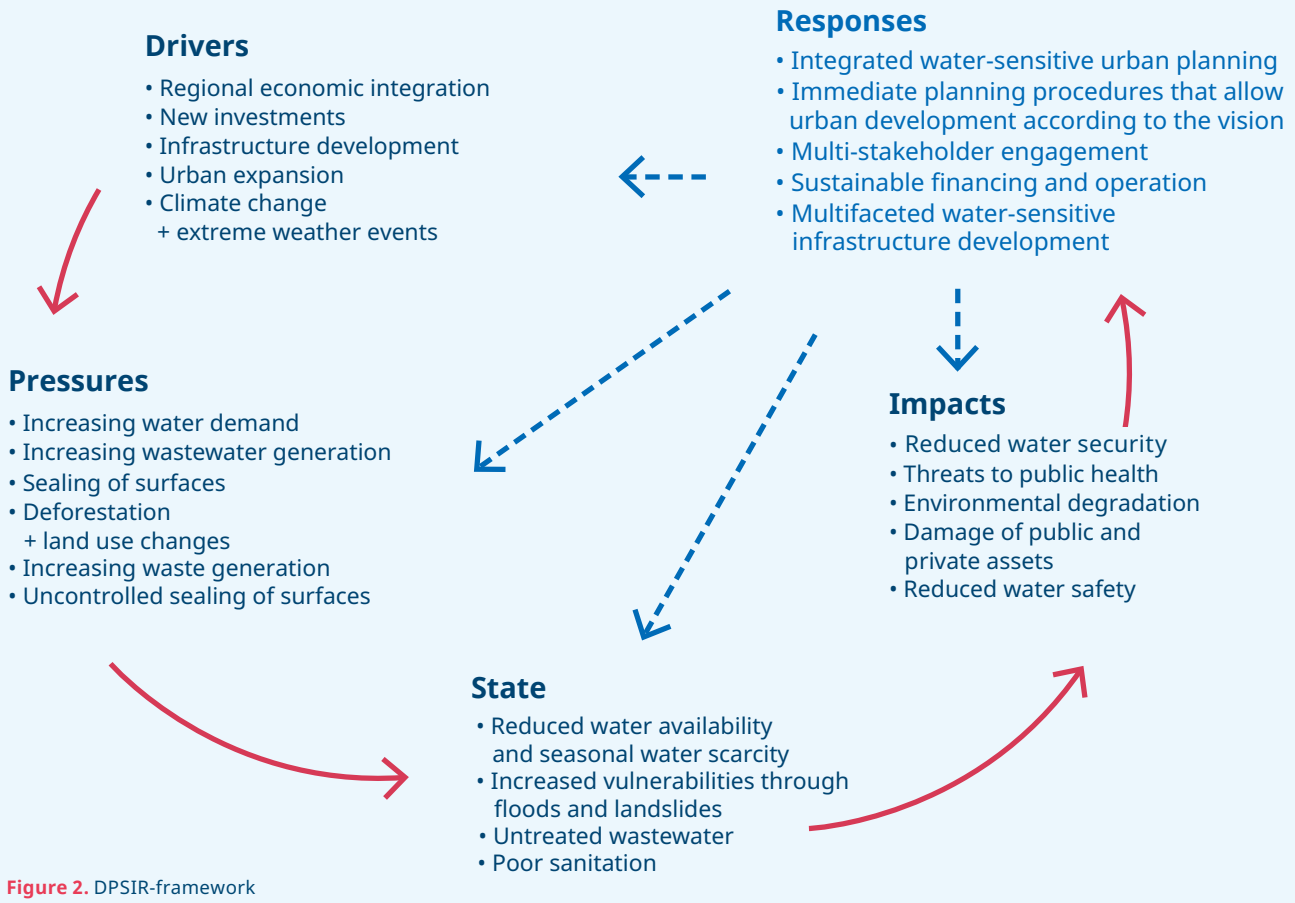


Figure 2. DPSIR-framework for Sam Neua with selected parameters

Source: (PUW, 2021)

PolyUrbanWaters Project Stages and Baseline Study Process

The concrete localization of the polycentric management approach to urban waters is guided by a co-production process consisting of three main steps (Figure 3):

1. **Baseline assessment** – what is the current status of water resources in the city? What are the trends of use and availability of water resources in the context of the urban development dynamics and external factors such as climate change?

2. **Scenario and vision building** – what are the potential implications of a "development" and what are strategic options for a water sensitive urban development?

3. **Transition pathways** – how can we formulate concrete steps to achieve the vision? What may be strategic intervention areas and what are the concrete steps to achieve the vision?

The Study represents the initial project stage of the PolyUrbanWaters research in Sam Neua town. Study findings are fed into the subsequent Vision Building stage whereby the Project's teams work with local stakeholders to collaboratively produce clear, realistic achievable visions and scenarios for the town. With these to guide the transition pathways, in cooperation with local stakeholders, the interface of urban planning and water management is explored, and actionable interventions designed.

The "baseline study – scenario building – transition pathways" process is guided by a strong science-policy dialogue and continuous capacity development.

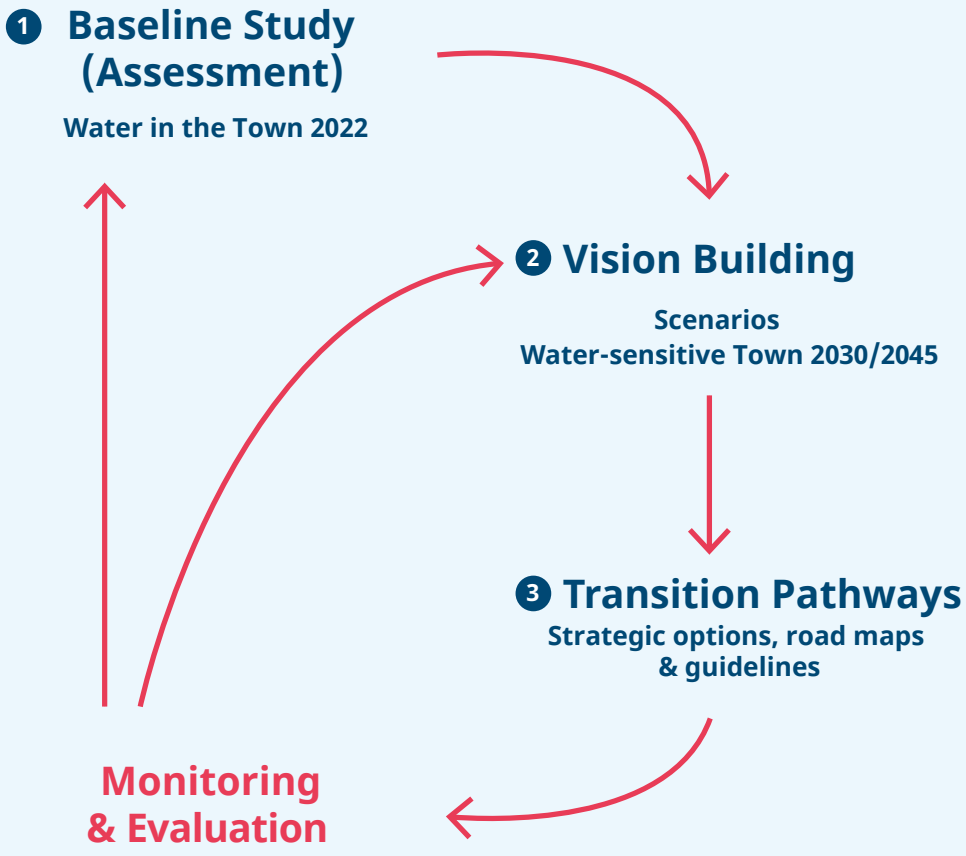


Figure 3. Main working process stages of PolyUrbanWaters project

Source: (PUW, 2019)

The development of the Baseline Study has followed four main stages as shown in Figure 4. Each Stage has been designed carefully and collaboratively with local partners in Lao PDR ensuring their agreement.

The first field visits took place in 2019 with the goals of establishing communication between project partners and conceiving a preliminary project design. Several research visits by international teams were planned for 2020 and 2022 to prepare the first draft of the baseline study. However, due to COVID-19 pandemic travel restrictions, these could not be carried out. As a result, the data collection, essential for the research process, had to be reorganized as below:

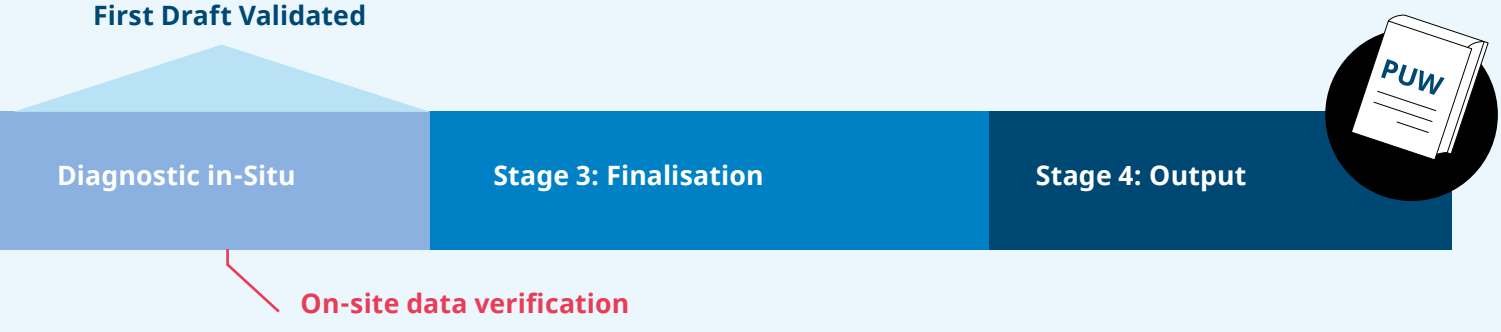
- Field data collection by international researchers could not be conducted, and so BORDA-Laos staff fulfilled this role while remaining in constant exchange with the international team via video conferences and other virtual communication tools. The data was primarily collected through interviews with relevant stakeholders from the municipal administration in Sam Neua, as well as provincial and national government departments.
- BORDA-Laos staff complemented this process through field visits to specific sites in Sam Neua.
- Important data, official documents and background studies with valuable information were provided by government agencies in Laos and international development partners.
- In addition, the international research team developed data for the project that is accessible for research via international databases.
- The entirety of this data was then analysed by the international research team with continuous feedback loops with the partners in Laos in order to come to essential conclusions about “Water in Sam Neua".

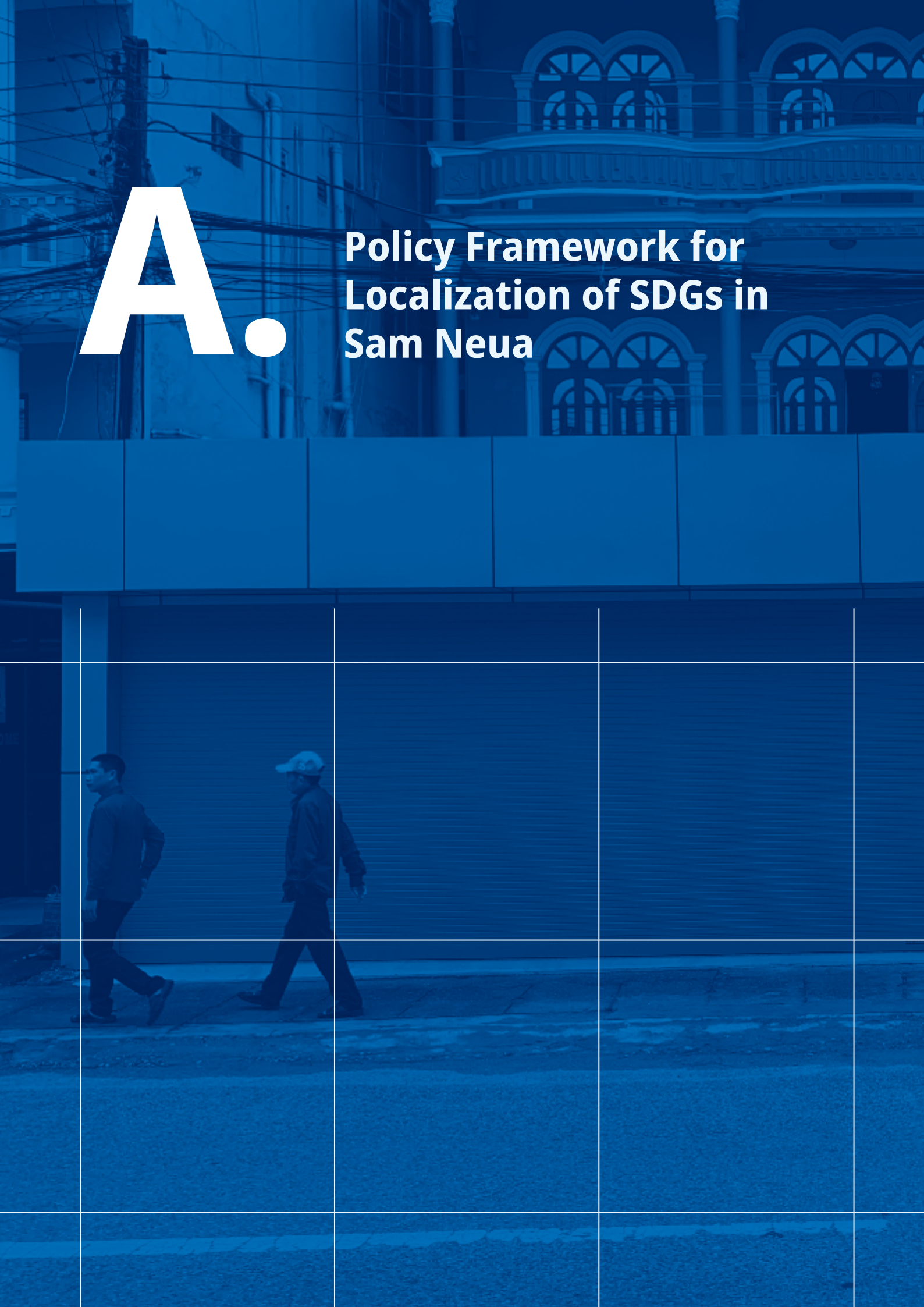
The initial draft of the Baseline Study with preliminary results of the research process was submitted and presented in person by the Laos and international PolyUrbanWaters Teams in June 2022 during a scheduled field visit. The draft provided the partners in Laos with an initial orientation of the research findings and a basis for communication of further development of the Baseline Study. Once COVID-19 pandemic travel restrictions were lifted, a field visit by the international team members was conducted providing opportunities to conduct important discussions to validate data, gather feedback (written and oral) and collect additional necessary information. During this visit, data verification used various methods, such as field visits, planned and random field interviews, manual mapping in the field (on printed maps), digital mapping in the meetings (mymaps.com), drone flights, as well as participatory mapping workshops (Figure 5). The feedback and input from local partners in Sam Neua and Vientiane, as well as the additional data collected on site, were crucial to the further development and finalization of this version of the baseline study. The study and its recommendations have been presented to representatives of the national, provincial and local government at workshop in Vientiane from 22 to 24 November 2022.

Figure 4. Main stages of Baseline Study development
Source: (PUW, 2021)

Figure 5. Participatory Mapping Workshops and data validation activity, Sam Neua, June 2022

Source: (TU Berlin, 2022)





A. Policy Framework for Localization of SDGs in Sam Neua

Key Messages of Section

The Lao PDR Government underlines its **strong commitment to implement the SDGs of Agenda 2030.** Its translation in the 9th National Social Economic Development 5-Year Plan (2021–2025) emphasizes challenges associated with the COVID-19, sustainability and climate change, quality and inclusive growth, human capital, infrastructure development and the transition from Least Developed Country status.

Already the first Voluntary Review 2018 states **"engaging local administrations in systematic implementation and monitoring is critical.** The effectiveness of implementing and monitoring the SDGs depends on a wide range of issues relating to local-specific contexts and challenges."

Overall, a strong regulatory and planning framework including various thematic guidelines have been developed over the years that need **capacities for localization.**

In the current District SEDP of Sam Neua, **SDG 6 Clean Water and Sanitation, SDG 11 Sustainable Cities and Communities and SDG 13 Climate Action** are priorities and integrated within the list of development objectives and requisite works/ projects.

As shown in the executive summary, In the process of the specification of **Sam Neua's vision,** the specific **SDG orientated indicators** may support its **implementation** and its **operalization**. The numbers may be specified during a planning process. Such indicators can also clarify to **international donors** the strategic value of specific interventions in terms of their **eligibility for funding.**

In its Second Voluntary National Review (VNR 2021), the Government of Lao PDR strongly underlines its commitment to the implementation of the 2030 Agenda for Sustainable Development and the achievement of the Sustainable Development Goals (SDGs).

For a water sensitive urban development, the following SDGs and targets are of particular relevance:

SDG 6: Ensure availability and sustainable management of water and sanitation for all

Targets:

- Ensuring universal and equitable access to safe, affordable drinking water, sanitation and hygiene for all
- Reducing pollution
- Increasing water-use efficiency
- Promoting participatory management of water and sanitation services

SDG 11. Make cities and human settlements inclusive, safe, resilient, and sustainable

Targets:

- Ensuring access to housing, basic services and public transport for all
- Participatory planning of human settlements
- Strengthening resilience to disasters

SDG 13. Take urgent action to combat climate change and its impacts

Targets:

- Strengthening resilience and adaptation to climate change and natural disasters, including in marginalized communities

According to the **First Voluntary Review** (2018, p. 8) *"engaging local administrations in systematic implementation and monitoring is critical. The effectiveness of implementing and monitoring the SDGs depends on a wide range of issues relating to local-specific contexts and challenges. These challenges require the government and local administrations to develop local monitoring systems, identify gaps, and implement corrective action to accelerate progress. To this end, the Government has already initiated institutional strengthening within local administrations to understand, implement, and monitor the progress towards the NSEDP goals and selected SDG targets. The Government's framework identifies four major governance themes: public service improvement, participation, rule of law and sound financial management. These four elements cut across every sector. Issues in service delivery, financing planning and management in health, education and other sectors need to be addressed from a governance perspective."*

In the **Second Voluntary Review** of September 2021, key learnings and a way forward were set out as follows:

- The Government's strong commitment to the 2030 Agenda lies within the greater involvement of line ministries and provincial authorities, motivating them to **have strong ownership of the SDGs localization** and implementation.
- Administrative data systems in many goals still need to be **harmonized**, streamlined and strengthened while enhancing institutional and statistical capacity building. Importantly, high quality and disaggregated data is essential to ensure equitable progress against the goals and targets.

- **Collaboration and coordination** across line ministries and between central-local levels and across different stakeholders will be built on via a multi-stakeholder engagement approach.
- The Government will continue working with all partners and identify a practical development financing strategy needed for implementing the 2030 Agenda.
- Of particular significance is public awareness of the SDGs to ensure greater support and partnerships that are essential to the realization of the SDGs.

At the national level, the actions for the implementation of SDGs are overseen by a National Steering Committee, including integration of targets and indicators into National and District Socio-Economic Development Plans; ten-year Development Strategy 2016–2025; and the Vision 2030.

Complimentary to planning processes, national planning for environmentally sustainable and resilient urban development has been strengthening over the last decade in Lao PDR. For instance, the nationwide strategy for the sanitation sector called the "National Strategy for Urban Sanitation 2016–2030", prepared by the WSD is aligned with "The Strategy of the Urban Water Supply and Sanitation Sector (2013–2030)" and includes SDG 6 with a focus on 6.2 and 6.3.

With respect to water management, the work of the Provincial Nam Papa' Houaphan Province (PNP HPAN) is guided by a number of policy and legislative frameworks (Ministry of Public Works and Transport, 2018):

- Service agreement with the Provincial Governor
- Water Supply Law 2009
- Water Quality Standard for Management for Drinking and Domestic Use Decision 561/MOH, 2014
- Law on Water and Water Resources defines regulations and measures for sustainable use, regulation and administration as well as preventing over-exploitation and damage to the water resources (ADB, 2018).
- Environmental Health and Safety Guidelines for Water and Sanitation (2007) provide guidelines for industry practices for water supply and sanitation projects (ADB, 2018).
- Natural Resources and Environment Strategy 2016–2025 (NRES 2016–2025) aims to achieve by 2025 sustainable use, management, protection and improve the environmental quality to ensure better quality of life and ensure adaptation toward climate change impacts; ensure effective implementation of the strategy and action plan produced by the MoNRE (GCF 2019).
- Urban Water Supply Strategy (2013)
- Strategy for Emerging Cities (2012)
- Water Supply Policy (2016)

The following framework documents, **intended for integration and activation in local urban plans** essentially indicate Lao PDR´s commitments especially in respect to the **adaptation to climate change**:

- **United Nations Framework Convention on Climate Change:** through the ratification of the Framework in Lao PDR, urban planning and development has changed course to emphasize natural disaster risks for urban areas and rural villages that are now exposed to seasonal flooding, erosion and landslides more frequently than in the past (Ministry of Public Works and Transport, 2021 p.20).

- **National Strategy on Climate Change 2012:** Based on the recommendations of the National Strategy on Climate Change, urban design and development shall include five adaptation strategies for climate proofing development, climate risk assessments, structural measures for vulnerable infrastructure, building codes and improved O&M of infrastructure in urban areas, (Ministry of Public Works and Transport, 2021, p.20) as well as a greater focus on sludge treatment and construction of sanitary landfill sites.
- Guideline on Mainstreaming Disaster Risks and Climate Change Impacts
- Guidelines on Integrating Disaster Risk and Climate Change into Village Socio-Economic Plans 2017
- Scaling-up Community-Based Disaster Risk Reduction in Lao PDR
- Community-Based Disaster Risk Reduction (CBDRR) Manual in Lao PDR 2020
- National Green Growth Strategy 2019

Localisation of the SDGs in Sam Neua

As with other towns in Lao PDR, local plans and planning activities are not directly oriented to achieving the SDGs **per se**, rather the aim is the National SEDP and District SEDP, **which integrate SDGs and associated national commitments**. This is also the case for the localization of the SDGs in Sam Neua town, whereby SDGs are **integrated** into the District's 5-year Social-Economic Development Plan (2021-25). This means that, while local administrative staff do not have a comprehensive knowledge of the SDGs and associated indicators**,** they have very good understanding and appreciation of the District SEDP goals, which they are working towards daily, and are aware that meeting targets set within their District SEDP contributes to Lao PDR meeting its national SDG commitments. In the current District SEDP, **SDG 6 Clean Water and Sanitation, SDG 11 Sustainable Cities and Communities and SDG 13 Climate Action** are priorities and integrated within the list of development objectives and requisite works/ projects. Annual monitoring of progress towards the SEDP targets is carried out by the provincial level Department of Planning and Investment. Performance in terms of meeting targets has an **impact on budget allocation**, thus motivating their efforts to achieve targets (DPWT, 2022).

Sam Neua District 5-Year Socio-Economic Development Plan and SDGs

Sam Neua town follows the greater Sam Neua District's Social Economic Development 5-Year Planning process with the latest edition (**SEDP No. IX (2020-2025)** guiding the development of the town to be a social and economic center with a sustainable environment through the promotion of **1) Agriculture and livestock, 2) Trade, 3) Silk weaving crafts, and 4) Tourist services.** This will be achieved via 1) ensuring stability through social peace and security, 2) economic growth and stability; 3) poverty alleviation for 14,92% of poor households by 2024; 4) **implementation of the Sustainable Development Goals (SDG) to be achieved 100%** (as discussed above); 5) increasing the capacity of government management efficiency; 6) protection and enhancement of the cultural customs and traditions of the locals, and promotion of a sustainable society; and 7) International cooperation and international organizations to enhance the technical support and funding under government policy

Targets focusing on macro-economic development are considered key, with the aim to improve the GDP for the next five years to achieve 1) 2.586,2 billion LAK or an average of 517,23 billion Lak per year, and 2) increase the average income per capita to 8.957.565 LAK or 1.079,22 USD per year: the agricultural sector accounting for 46.17 % of GDP; Industrial and handicrafts sector accounting for 11.9 % of GDP; trade and services accounting for 41.93 % of GDP.

Sector Targets are summarized from the plan as follows:

Investment: implementation of six programs and 61 projects with total investment of 108.917,49 million LAK, with the following breakdown:

- Government investment in 17 projects, total budget 19.527,38 million LAK or 17.93 % of total investment;
- Grant and loan ODA: enhancing funds from friendship countries and international organizations, particularly the two friendship cities of 1) Son La Town and Tang Hoa Town in Vietnam to implement 20 development projects with 26.228,11 million LAK or 24.98 % of total investment budget;
- Internal and external private investment for 13 projects with 51.412 million LAK or 47.2 %;
- Public investment: encourage and support people for commercial goods production by contributing co-funding for infrastructure construction for 12 projects with 11.750 million LAK or 10.79 %.

Goods Production: Opportunities to increase production are through poultry farming, livestock raising, fish raising, rice field maintenance and expansion, mak kao or oil tree cultivation, mulberry cultivation, and silk weaving.

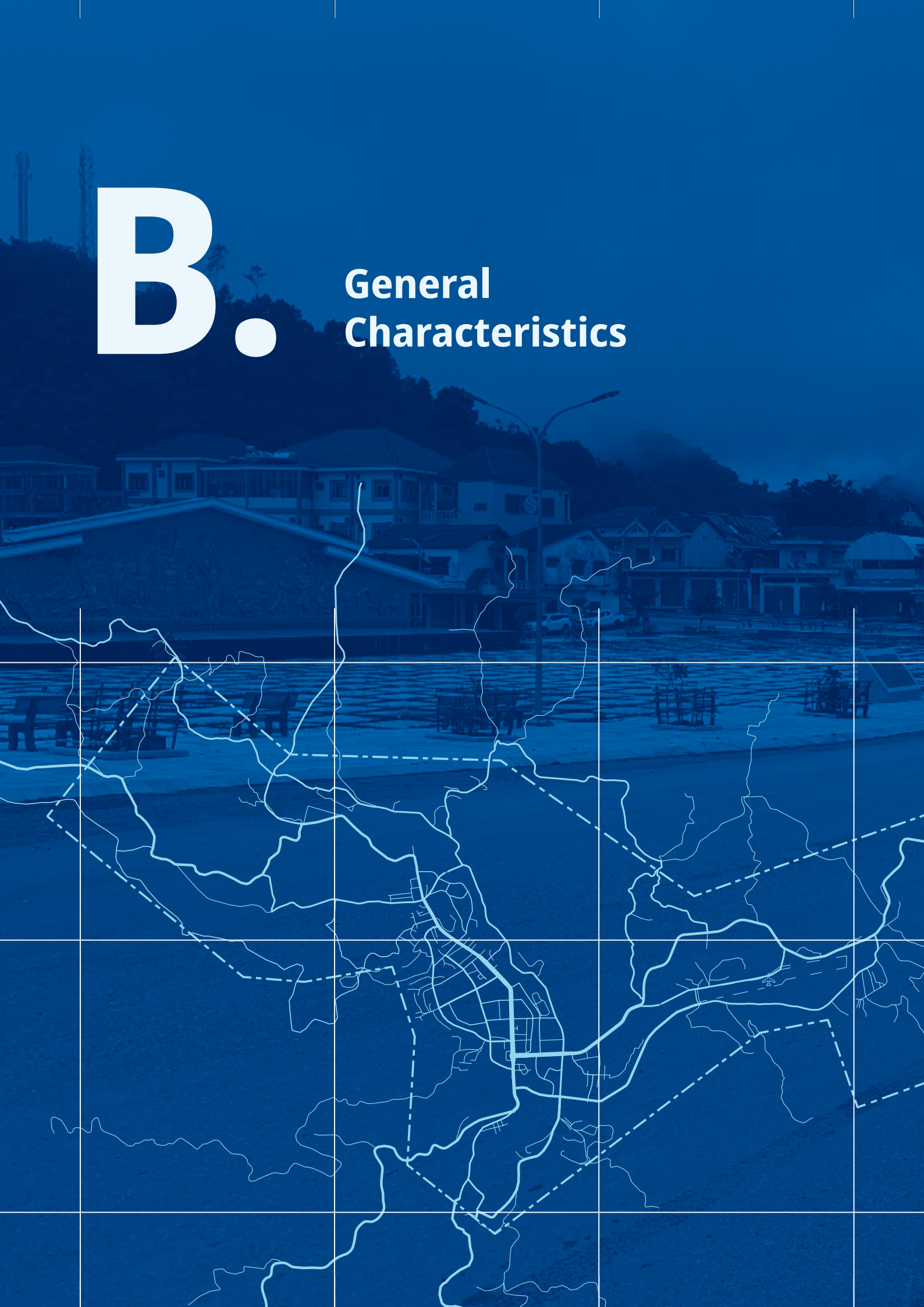
Infrastructure:

- Further construction, repair and expansion of the infrastructure access system in urban areas and promote responsibility for operation and maintenance at the village level for roads, drainage and open channels. Upgrading of urban roads, walkways and stormwater channels for four routes of 3.2 kms; roadside pavements of 3.6 km; construction of 8.3 kms of new community access roads, the maintenance of two bridges over the Nam Xam River, and construction of wastewater treatment systems at four urban village sites.
- Urban planning: improve current urban planning processes and increase the efficiency of the implementation of urban planning regulations, particularly for construction permits, land excavations and fillings to comply or cover 80 % of the urban planning area.
- Urban management and services: Increase solid waste collection services for four more villages, promote solid waste separation to reduce waste by up to 7 %, and increase tree planting and town decoration.
- Improve agriculture in 27 locations to serve 517,090 hectares and construct two water basins;
- Construct ten primary schools and five nursery schools.

Rural Development and Poverty Alleviation: This aims to transform grassroots political actors linked to development; eradicate poverty, and continue to allocate settlements and gather small villages into larger administrative areas.

B.

General Characteristics



Key Messages of Section

Sam Neua continues to **gradually transition from a small, isolated rural town to a larger, "land-linked" provincial centre** with secondary city status.

Today, Government service and farming are the main occupations in the town, followed by trade. The town is promoted as a center of **trade, service, culture, and tourism.**

Urban growth is projected to continue and accelerate due to a combination of major investments and development drivers, which can generate **economic growth and improved living standards when development is carefully planned and controlled.**

The topographical location of Sam Neua, situated in a narrow valley, means **a very limited spatial expansion potential for the town.** If the town's population is to nearly double over the next two decades, inward growth is likely.

Without systematic planning there is **a risk of urban sprawl and a very high amount of sealed urban area resulting in associated water-related vulnerabilities, a heat island effect and the loss of the town's attractiveness.**

Urbanization is taking place with **minimal coordination, inadequate infrastructure, and insufficient regard for environmental impacts** resulting in disorganized growth, inefficient land use, damage and loss of natural resources, and inadequate access to urban services.

A future scenario following the current urbanisation and development trajectory and trends is likely to be a more complex and dynamically formed town with a much denser, built-up urban core, higher land-values, more vertical expansion via multi-story buildings and displacement of lower income groups to more affordable urban periphery areas.

Infrastructure developments, such as the new airport and the planned Special Economic Zone, should **support economic diversification and dynamism.** The fact that the opening of the airport is delayed primarily due to the lack of a secure water supply, highlights the necessity of comprehensive and long-term water management security.

Sam Neua, Laos

Location:
Northeast Laos, Houphan Province

Villages:
12

Population (2019):
Town 17,000; Projected by 2045
between 50.000 – 100.000 (CDE, 2018)

Figure 6. Geographical position of Sam Neua

Source: (TUB, 2020)

Geographical Position and Population

Situated 594 km north-east of the capital Vientiane and 70 km from the border with Viet Nam (Figure 6), Sam Neua town (Figures 7 and 8) is the center of Sam Neua District and the capital of Houaphan Province, a relatively isolated sub-tropical, mountainous highland area with steep terrain, limestone mountains and caverns, densely forested, and dominated by agriculture. Heavy rain is experienced in the wet season, between April and October. Primary overland road access to the town is limited to National Highway No. 6. Overall, Houaphan Province has a total area of 2,658 km^2 (DoNRE, 2018).

More specifically, Sam Neua District has a forest area of 136,691 ha, agricultural land of 6,420 ha, National Protection Area of 29,256 ha, District Conservation Forest of 325 ha, District Protection Forest (water resources protection area) of 53,592 ha, Protection Forest of 47,534 ha, and Rehabilitation Forest of 6,047 ha (DoNRE, 2018).

Currently, the long travel times to neighboring provincial cities and Vientiane by road, together with limited alternative access options, significantly contributes to the overall isolation of the town.

Figure 7. Sam Neua Town
Source: (TUB, 2019)

Population and Urbanisation

Lao PDR has a low population and density compared to other countries in Southeast Asia. The capital, Vientiane, has a population of just over half a million, far less than Bangkok, at approximately 9.5 million or Phnom Penh, at around 1.7 million, (CDE, 2018). (See Annex: Population growth projections for Sam Neua compared to other Laotian towns). Population projections in Laos by Total, Urban, Rural (1950 – 2050) are shown below.

Houaphan province has a population of **280,000 people** across twenty-seven (27) ethnic groups. More than 94 % of the population lives in rural areas. (ADB, 2009). The average population density of **18 persons / km^2 is relatively low for Asia.** The annual population growth for Houaphan Province is significantly low at 0.3 %.

The population of Sam Neua town itself, in 2018 was reported as 18,187, divided over twelve urban villages (ADB, 2018). Sam Neua District, in which the town sits, consists of 13 Koum Ban (village cluster), with a total population of 59,977 people (29,345 females), 9,187 households, and 109 villages. The average population density of the district is 23 persons / km^2 (DoNRE, 2018). The population spatial distribution pattern holds the highest density concentration around the central built-up areas then gradually reduces from the center to peri-urban areas.

Urbanisation

Urbanisation is occurring rapidly in Lao PDR due to rural-urban migration. Despite Lao PDR being predominantly rural, with more than two thirds (67.1 %) of the people living in areas defined as rural, it holds the highest urbanization growth rate in Asia, at a rate of 4.9 % (twice the global average of 2 %), which is placing considerable pressure on urban and emerging urban settlements (UN HABITAT, 2021). By 2050, it is predicted that 60 % of residents will live in urban areas, with an annual average urbanization growth rate of 2.9 % (ADB, 2018).

Urbanisation in Laos PDR is seen as a key contributor for generating economic benefits (Figure 9). In 2016, around 55 % of Lao PDR's GDP (US$8.83 billion) was generated in urban areas. Employment growth is also mostly taking place in urban centres, which are therefore viewed as key for driving development of the national economy over the next 20 years (ADB, 2018). Vientiane and the secondary cities located along the Mekong River are key drivers for the nation's urbanization, yet smaller towns, such as Sam Neua, are located outside this axis (Lainé, 2015).

Sam Neua Town

Sam Neua town lies within an area characterized by poor connectivity, typical for north-eastern Laos along the border with Vietnam. Such areas typically face the highest poverty and migration rates, and the slowest growth (ADB, 2018).

However, despite its isolation, there are substantial indications that Sam Neua town is undergoing a steady developmental transformation into an important larger provincial capital. This is also asserted by the Centre for Development and Environment (CDE) which indicates that Sam Neua town and the district will experience an increased level of development that is expected to quadruple the urban population, with indications that the town will have a population of 50,000 – 100,000 by 2045. (See Annex. Population Growth Projections for Sam Neua Compared to Other Laotian Towns). The main cause of growth for these small towns include: "Search for employment" 22.2 %; "Family migration" 15.9%; "Education" 12.5% (CDE, 2018). Such a high projected growth for Sam Neau town can be associated with the political and economic incentives employed by the national government and enjoyed by the private sector, placing Sam Neua as the focus for development in eastern Laos through the "North Eastern Corridor" of the Greater Mekong Subregion (CDE, 2018; PUW, 2019). The new international airport at Ban Nong Khang (located 21 km to the North of the town) and planned improved road access (via the widening of National Road 6) will help to significantly improve accessibility and consequently generate growth while contributing to the development of the town as a tourist destination and its internationalization (Hodgson, 2019). In addition, fulfillment of the planned Nookhan Special Economic Zone (SEZ) located near the new international airport is also likely to be a considerable driver of population growth over the next decades (See Annex. New International Airport at Bang Nong Khan and Nookhan SEZ 21 km North of Sam Neua Town).

A future scenario following current development trajectory and trends is a more complex and dynamically formed town with a much denser, built-up urban core, higher land-values, more vertical expansion via multi-story buildings and displacement of income groups to the more affordable urban periphery (this finding is further elaborated within the Baseline Study).

While such a transition is seen as desirable and necessary by national and local stakeholders, according to ADB (2012), Lao PDR's urbanization is taking place with minimal coordination, inadequate infrastructure, and insufficient regard for environmental impacts. The results include disorganized growth, inefficient land use, damage and loss of natural resources, and inadequate access to urban services. The problems can be attributed to poor urban management, limited strategic spatial planning, poor connectivity between urban planning and environmental management, and insufficient investment in infrastructure and community services.

Figure 8. Town map, Sam Neua

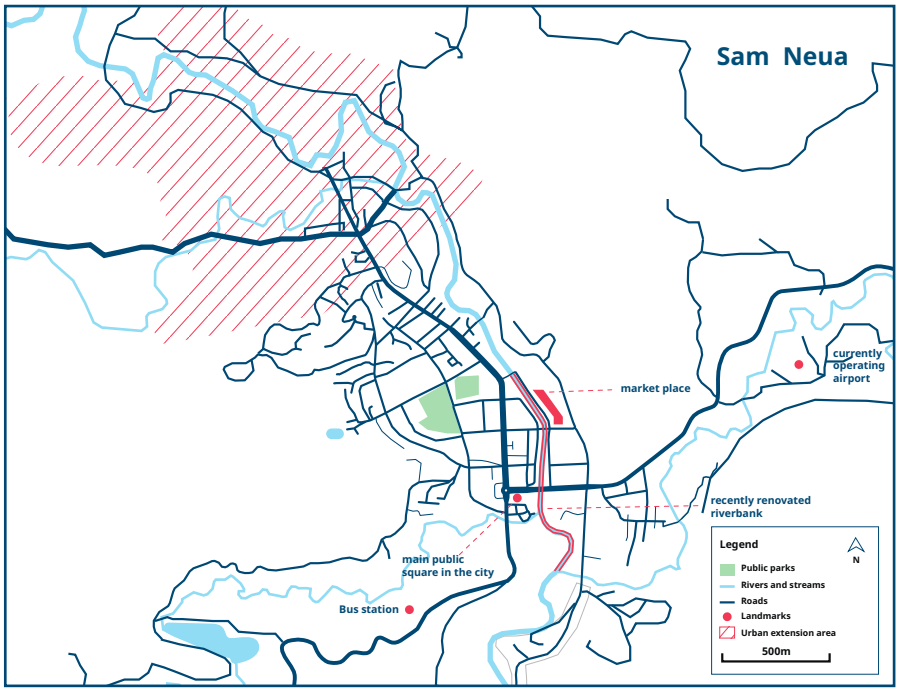


Figure 9. Population in Laos by Total, Urban, Rural (1950–2050) in Mio.

Source: (United Nations Population Division, 2018)

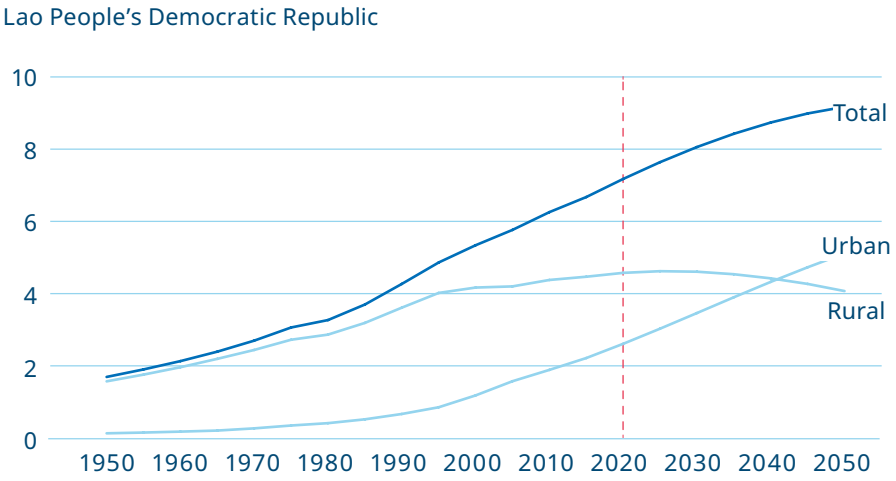
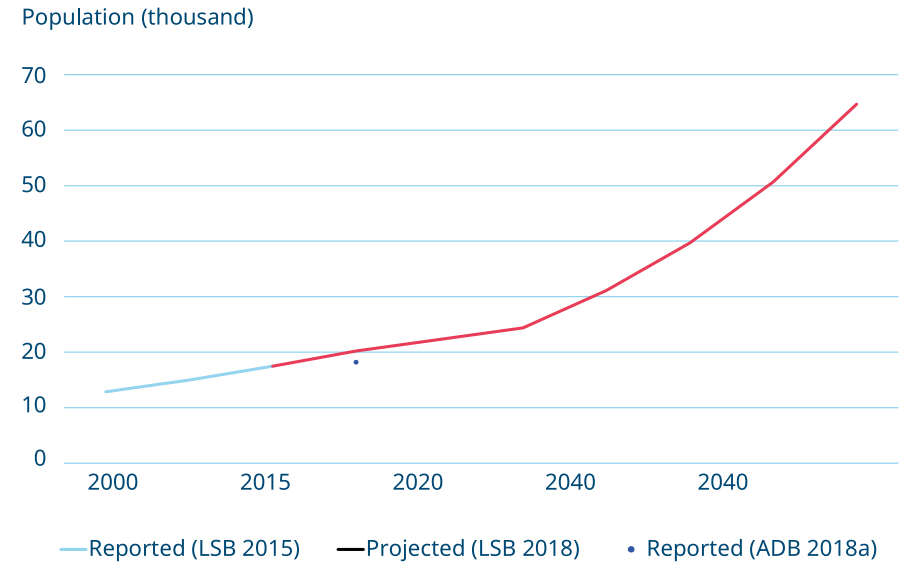
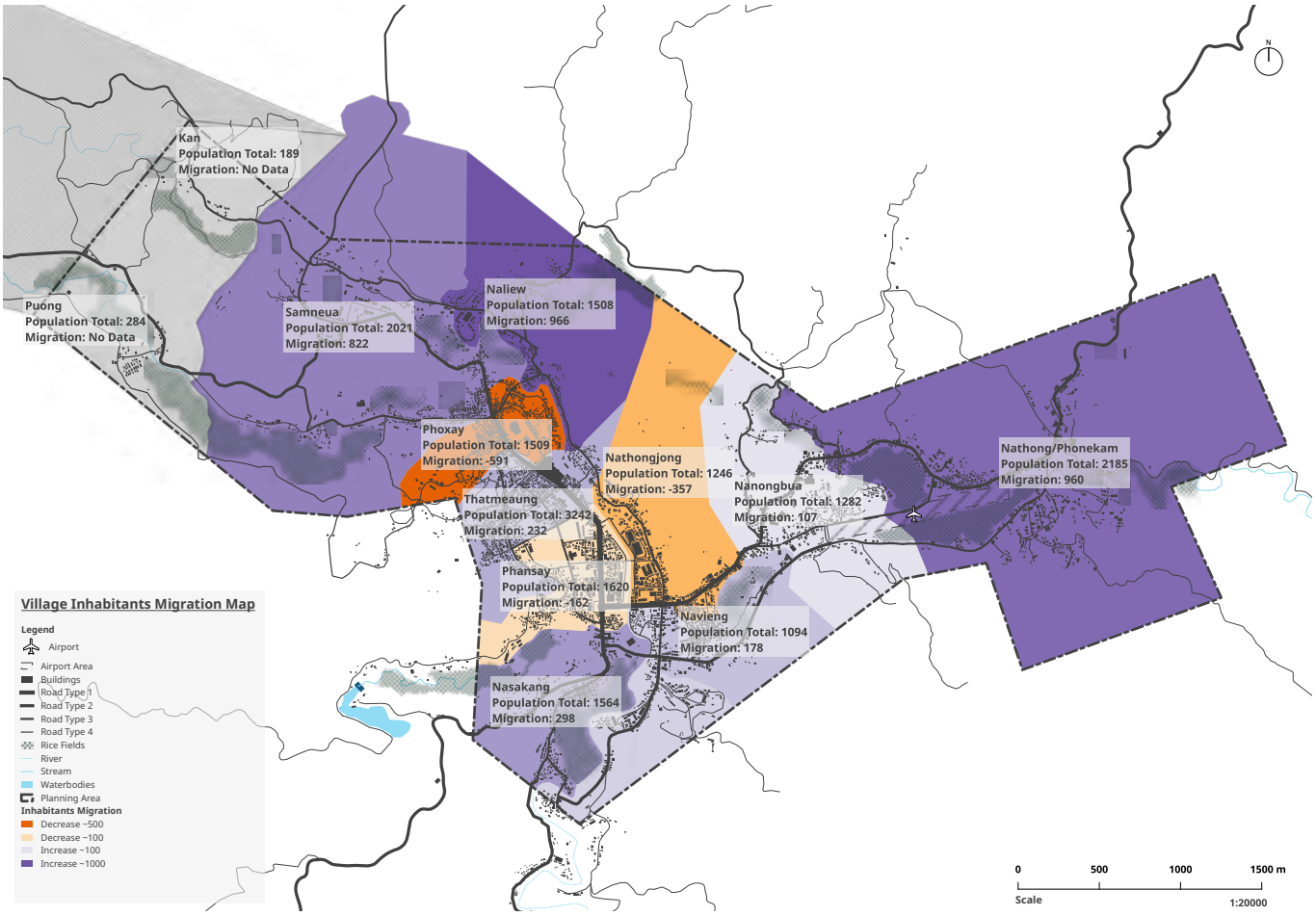


Figure 10. Historical and population growth projections for Sam Neua

Source: (ADB, 2018; Lao Statistical Bureau (LSB), 2018; Lao Statistics Bureau (LSB), 2015))adapted by ITT 2021)





Socio-Economic Profile

Economic growth in Lao PDR is estimated to have decreased from 6.3 % in 2018 to 4.8 % in 2019. The Government policy of fiscal consolidation is partly due to the fiscal pressures following the 2018 floods. The high level of debt and low level of international reserves increases the economy's vulnerability to shocks. Since 2017, the IMF has classified Lao PDR's risk of external debt distress as moderate to high (UN, 2020).

More recently, COVID-19 and the associated containment measures have heightened macroeconomic vulnerabilities and slowed economic recovery. GDP growth is estimated to have been about 2.5 % in 2021 while inflation increased from under 2 % in February 2021 (year-on-year) to 9.9 % in April 2022 threatening living standards, especially in low-income urban households. GDP growth is projected to recover to 3.8 % in 2022, provided that ongoing debt renegotiations are successful and strict COVID-19 containment measures are not reinstated (World Bank, 2022).

The dominant livelihood activities in Sam Neua District includes lowland rice agriculture (40 %), upland rice agriculture (60 %), animal raising activities (40 %), small trades (30 %), services (20 %), and others (10 %) (DoNRE, 2018).

Generally, in Lao PDR there are above average levels of poverty for those working in the agricultural sector, and Sam Neua Disrict is no exception where there is a high dependence on agriculture and a notable presence of ethnic minorities. (Heinimann et al., 2013). According to 2015 census data, there is less than 10 % poverty for most of the population in Sam Neua town itself, while poverty figures rise considerably in the surrounding district (Map Analyst Lao PDR, 2022).

Figure 11. Population distribution of Sam Neua villages

Source: (based on data Sam Neua District Government in ADB 2018, 2021) (TUB 2022).

Sam Neua District is composed of nine ethnic groups including: Lao Loum (43%), Hmong (33%), Khmu (11%), Tai (7%), Iu Mien (0.06%), Phong (5.1%), Meuang or Moy (0.83%), and Chinese or Hor (0.31%) (DoNRE, 2018). This ethnic diversity coupled with national initiatives seeking the development of tourism through the promotion of this local cultural diversity, highlight the importance of tourism to the local population, especially when connected with the modernization of infrastructure (Goudineau, 2015).

As a burgeoning provincial capital, the town area is the administrative, commercial, and social center of Houaphan Province. In the town, there are eleven primary schools, four high schools, seven clinics/hospitals, three markets and six temples. Government services, commercial services, agriculture and trade dominate the local economy (ADB, 2018).

Sam Neua District: Health Status

According to data from the DoNRE (2018), by 2018 the District had nine community health centres (Souksala) with 106 drug boxes throughout the District's villages, and 14 pharmacy stores. The maternal mortality rate per childbirth was 200/100,000 persons. Infant mortality rate (below 1 year old) was 30/1,000 persons. Under-five child mortality rate was 45/1,000 persons. In general, healthcare services covered 100% of the district's villages, and the life expectancy of its people was 73 years.

Figure 12. Image of gradual transition and growth of the town over the last decade shown by large investments in public infrastructure such as new large-scale government administrative offices, public buildings spaces.

Source: (TU Berlin, 2019–2022)

In a physical sense, this urban transition is **based on significant investments in public infrastructure**, such as new roads, new large-scale government administrative and public buildings, public spaces, and multiple urban extension areas converted from agricultural fields.

This transition is also reflected in the town's annual increase in production, consumption, expenses, and investments totaling an increase of 11.8% over the last decade, with the largest growth occurring in agricultural production and the trades and services sectors (GoLPDR, 2014). The **local authorities' five-year development plan perceives the town as a center for trade, service, culture, and tourism with the production of related goods, such as textiles and other souvenirs.** Agriculture and livestock, weaving crafts, services and eco-tourism have the greatest social economic development potential (GoLPDR, 2014). Handicrafts are one of the key activities that have increased significantly, particularly the activities that have cultural heritage value and are iconic features of the province.

Government service is the main occupation in the town of Sam Neua with the provincial and district providing employment to approximately 24.5% of female and over 40% of the male household heads. Farming is the second largest occupation at 19.8% of the male household heads and 28.2% of the female, followed by services and industry occupations (ADB, 2018).

The average monthly income per household is 5.67 million LAK, while the average monthly income per person is 1.21 million LAK and the median monthly income per person is 1.0 million LAK (at 27/02/2018, currency equivalent of Kip (KN), KN1.00 =$0001205; $1.00 = KN8,294) (ADB, 2018). The Lao/Tai Daeng/Tai Dam groups have the highest median incomes in the range of 920,000 to 1.17 million LAK/month with the Khmu and Hmong groups much lower in the range of 290,000 to 450,000 LAK/month (ADB, 2018).

Sam Neua District: Literacy and Education Status

In 2015, the District had a total of 41 kindergarten schools with 1,874 children, 127 primary schools with a total 8,510 students, and 14 lower secondary schools with a total 5,347 students. The District has nine upper secondary schools with a total of 3,138 students. There is one new model school, which was launched in 2015. Net enrolment in primary school is above 80% in Sam Neua. Upper secondary school completion rates reached 100% compared to the planned targets. Enrolment rates at this time were generally increasing (DoNRE, 2018).

The working age population between 15 and 64 has a literacy rate that is above 90% with pockets of lower levels of literacy outside of the town. 15 to 24 years olds have higher literacy rates between 90 and 99% with those speaking similar languages to Lao having higher rates of literacy than groups that do not (Lao Statistical Bureau (LSB), 2018).

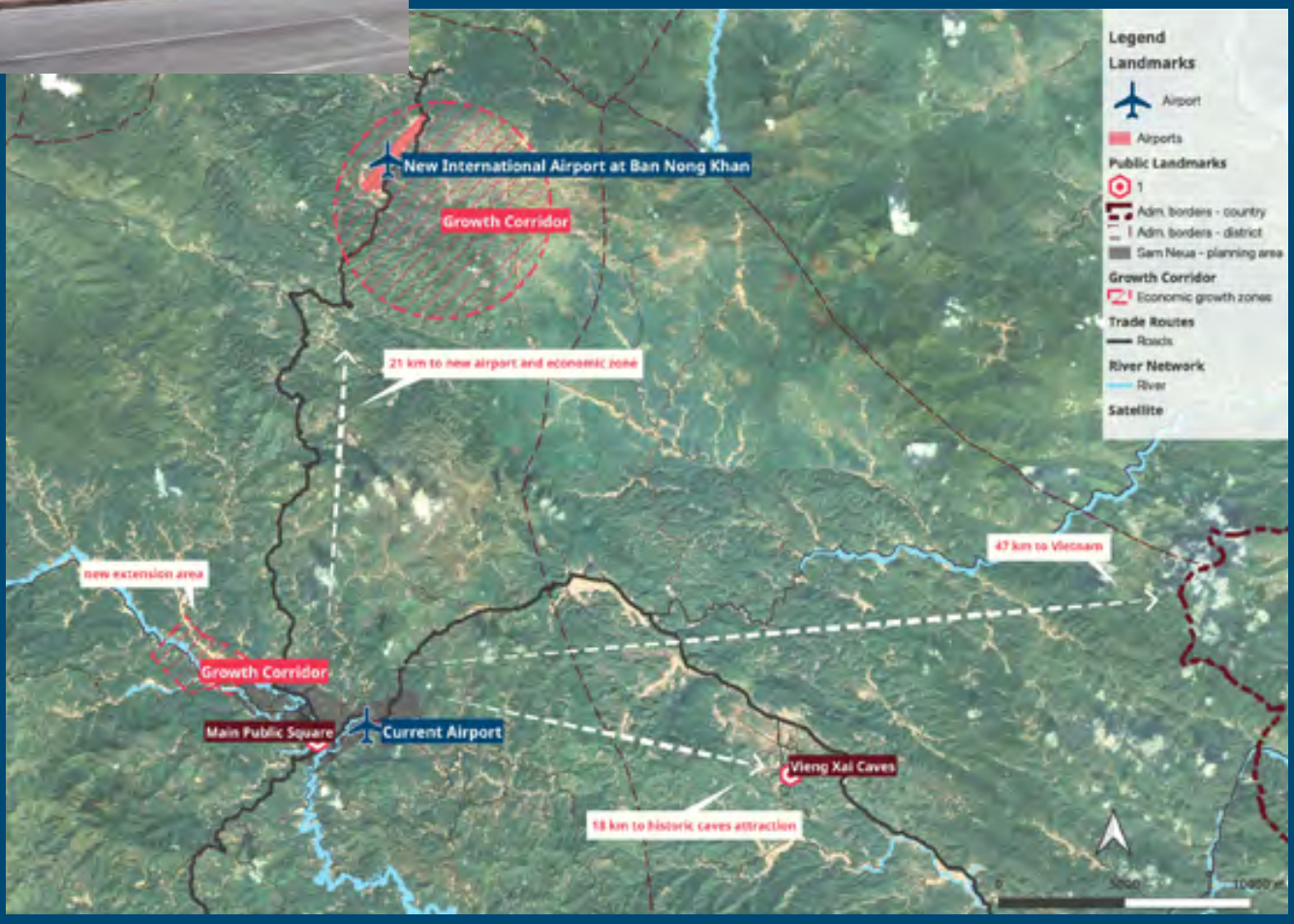
Water in the Town – Story 1

Land Locked to Land Linked. Making Sam Neua a more Connected; Accessible and Prosperous Town

A major development project expected to have a considerable impact on Sam Neua is the new international airport at Ban Nong Khan 21km north of the town. The airport is an initial investment constructed by a major Vietnamese investment company focused on agriculture and real estate.

According to the investment master plan for the new airport, the surrounding area is planned to become a Special Economic Zone called “Nookhan SEZ”. This development, in combination with Sam Neua’s strategic position on the planned GMS Northeastern Corridor, is likely to be attractive to investors from a range of sectors, such as agriculture, real estate, tourism.

There are already indications that private international investment (cross-border from Vietnam) is affecting urban change processes in Sam Neua. Overall it is expected that significant socio-economic and development opportunities will be created for the town, as well as challenges for the local authorities to provide basic infrastructure while managing growing pressure on the local environment.



Key Investment Drivers and Trends

A key focus and strategy of the Lao PDR Government is to promote rapid economic growth to raise the country's status above that of a Least Developed Country (UCRSEA, 2017). Following the New Economic Mechanism 1986 (NEM) (Transition to a Market-oriented System) urban development has thrived. This instigated a new urban development era in which international trade is promoted, state enterprises are allowed to access markets and importantly, there has been strong promotion of large-scale foreign investment in urban areas with a corresponding increase in rural-urban migration (UCRSEA, 2017).

Currently, the Lao PDR is striving for stronger economic integration into the Greater Mekong Sub-region's (GMS) markets, through promoting economic growth by reducing obstacles to cross-border trade. The GMS Plan contains various transport corridors to facilitate movements of goods and capital, whereby investment is prioritized and import and export obstacles reduced. Most of the investment focuses on (upgrading) transport infrastructures, such as bridges, roads, and border facilities (Figure 14). Sam Neua is located on the planned "Northeastern Corridor" of the GMS (Figure 13). The implementation of the corridors strategy is likely to give more functions to cities located near the borders and along these corridors due to their increased potential to attract private sector investments (Lainé, 2015). According to CDE 2018, if the north-eastern section of the China-Indochina Peninsula Economic Corridor through Sayaboury and Sam Neua materializes, the importance of these towns would increase with implications for population growth and urban development. In Sam Neua town and surrounds, investments in infrastructure serve to provide fiscal incentives to investors. In other towns, such measures have been shown to attract investment, yet local authorities face challenges to coordinate the development projects while ensuring that hey meet the local population's needs (Lainé, 2015).

Figure 13. Sam Neua on the North-eastern Transport Corridor (light green) of the GMS

Source: (Charts (GMS. (n.d.). http://portal.gms-eoc.org/)

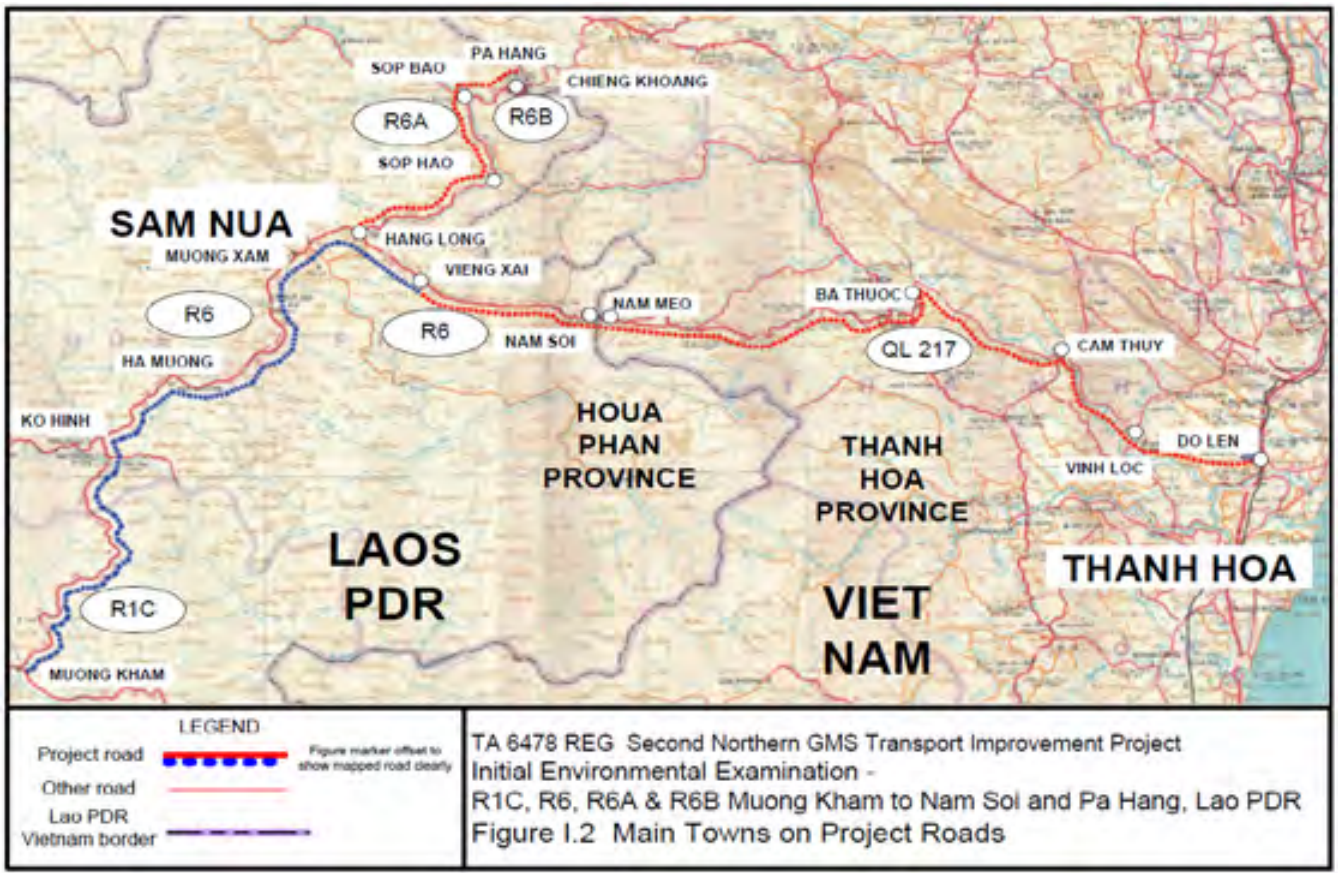


Figure 14. The current road upgrading/widening project (feasibility study pending) along the National Road 6 between Muong Kham and Vieng Xai will significantly improve access to Sam Neua.

Source: (ADB, 2009)

Agricultural Production

Still today, agriculture is by far the most important economic sector in the District with a total land use area of 6,420 ha. which contributed 65.19 % of GDP as of 2018 (DoNRE, 2018).

Agricultural area consists mostly of rice, but also small amounts of corn, taro-legumes, mandarin orchards and cassava. In the time between 2013 and 2017, especially orchard areas have increased the most from 170 ha to 988ha. Sam Neua District has a total number of 320 irrigation schemes (2354 ha) that include permanent, wooden, piped and traditional waterwheels.

Rain-fed rice paddies and swidden ("slash and burn") rice cultivation remain the predominant agricultural practices occupying an area of 5,240 ha. (DONRE 2018), and includes much land within the town´ boundaries, particularly in urban expansion areas (See Figure 14 above showing rice paddy field adjacent to the new hospital and residential area). Until today, production is for the Sam Neua internal market and exported to other provinces.

In future, foreign investment is supposed to play an important role in the development of agro-business in the district and province. Land may be converted for intensive agricultural production and capital intensive agro-processing may significantly contribute to socio-economic development (PUW Interview with Department of Planning and Investment, 2022).

Traders from neighbouring countries such as Vietnam already have headquarters in Sam Neua District with contract farming arrangements (VFI, 2019). The main cash crops in the district are coffee and tea, other cash crops include vegetables, soya beans, cassava, green beans, peanuts, corn, a variety of fruit trees among other crops.

Increasing vulnerabilities to land degradation and related declining crop yields are observed in the district (DoNRE, 2018). Without sustainable land and agricultural management practices this may exacerbate significantly in future and be a major threat for socio-economic development (DoNRE, 2018).

Figure 15. Aerial photo of paddy fields and forests of Sam Neua

Investment in Tourism

Tourism is an important sector in Lao PDR, with strong growth in tourist arrivals and spending over the past decade. The promotion "Visit Laos-China Year" in 2019 aimed to achieve one million Chinese tourists visiting Lao PDR. By 2025, it is estimated that visitors will reach 2.5 million, aided by a new transport link, the Lao PDR-China railway from Vientiane to Kunming, opened in December 2021. **Ensuring that Lao PDR citizens, particularly those in rural areas, benefit from the growth in tourism is a government priority, thus a strong and competitive tourism sector is seen as critical** (UN, 2020).

The flow of tourism benefits is also a target for Sam Neua District, as seen in the current and past District SEDP, which contains the target to create the 35 villages culture, attracting tourists both local and overseas to visit the town 242,736 times, and earn more than 50 billion LAK (SEDP, 2020). Figures indicate that mainly domestic tourists visit the district in gradually increasing numbers annually. However, domestic tourist numbers also include business travelers and seasonal workers for harvesting. International tourism is relatively low in comparison. With the commencement of the new international airport, there are high expectations that domestic and international tourist numbers are expected to increase significantly. **Efforts are being made to promote** the area for eco-tourism as well as the important national historical political significance of the area as the birthplace and centre for the fight for independence (Figure 19). Of special significance for eco-tourism in the Province are the **Nam Et-Phou Louei, the largest national park in Lao PDR and Xam Tai protected areas** in Houaphan (Figure 18). Additionally, the **Xuam Nha Nature Reserve in Vietnam** is on the border near the Pa Hang border post on the national road R6B in Lao PDR.

Figure 16. Vieng Xay Caves in Houaphan Province, Laos
Source: (PUW, 2019)

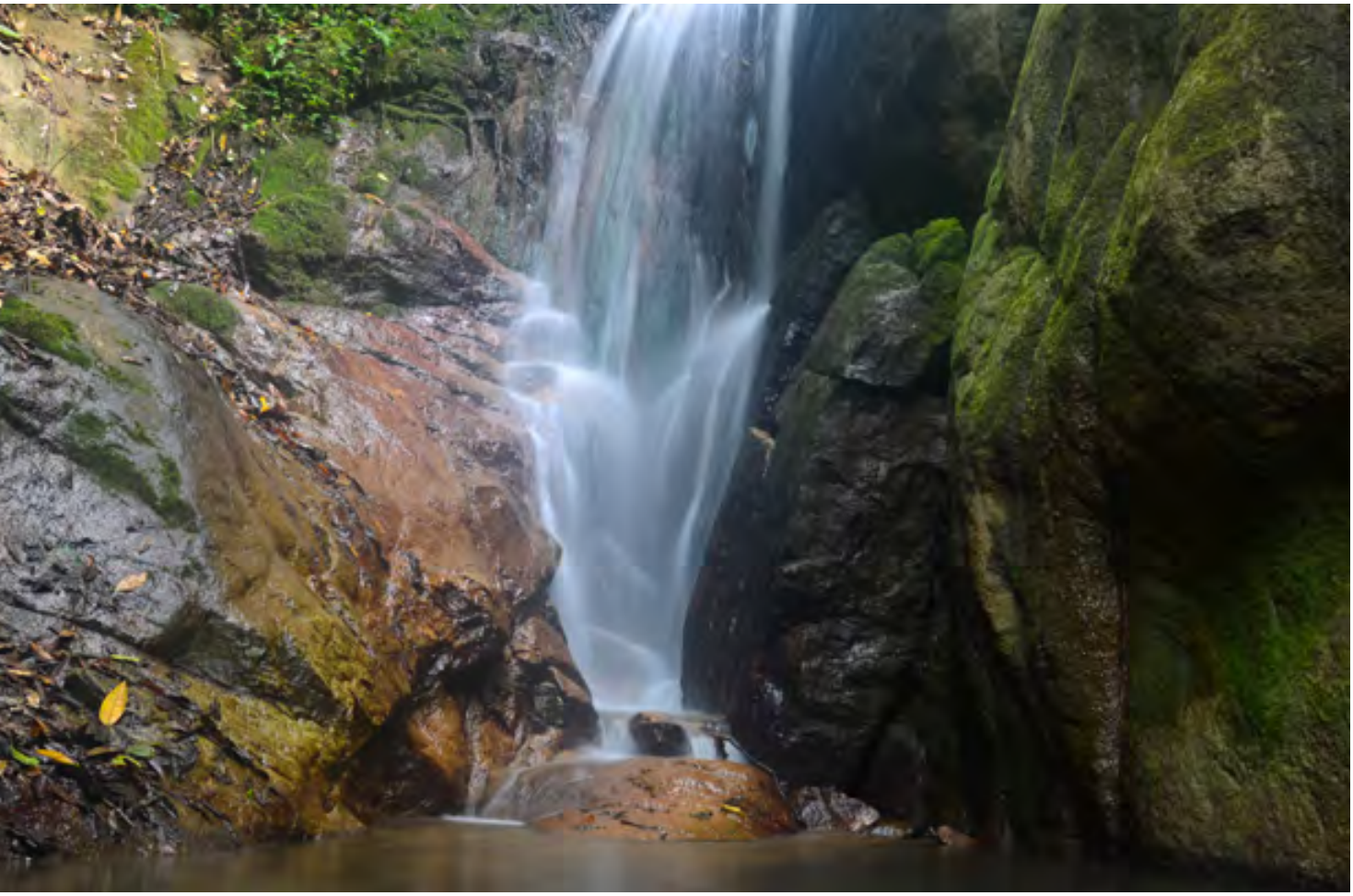


Figure 17. Waterfall at Nam Et-Phou Louey National Park, Laos.

Source: (flickr.com/photos/globalwaterforum (CC BY-NC-SA 2.0))

Year	Domestic Tourists	Intl. Tourists	Total	Percent of Increase
2014	2250	250	2500	38 %
2015	2700	300	3000	38 %
2016	3170	330	3500	37 %
2017	3640	360	4000	34 %
Total	**11760**	**1240**	**13000**	**37 %**
2020 (Target)	4450	450	4900	42 %

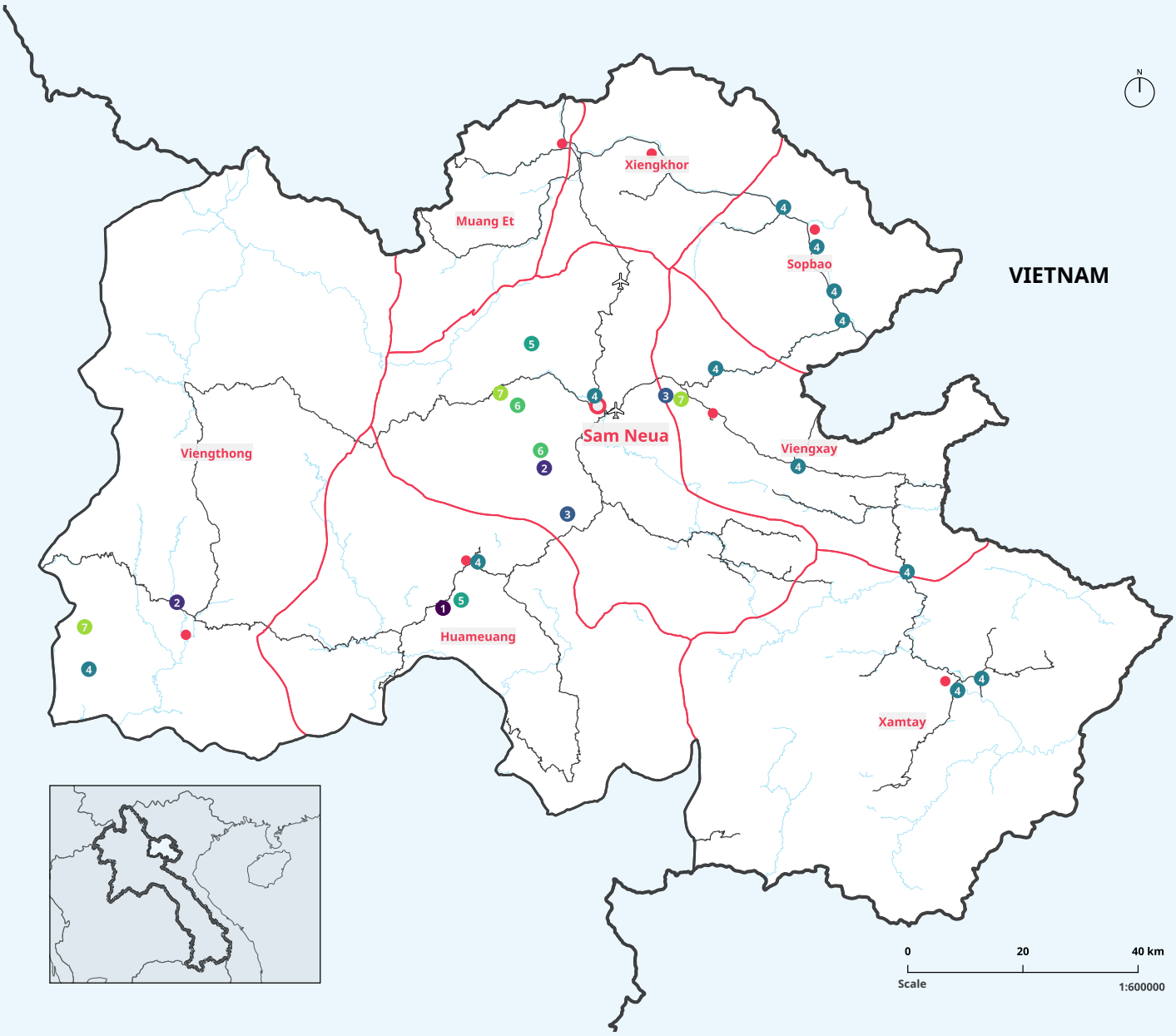
Figure 18. Number and Targets for Domestic and International Tourists Sam Neua District

Source: (DoNRE, 2018)

Key Sites in Houphan Province

Figure 19. Key tourism sites of Houaphan Province

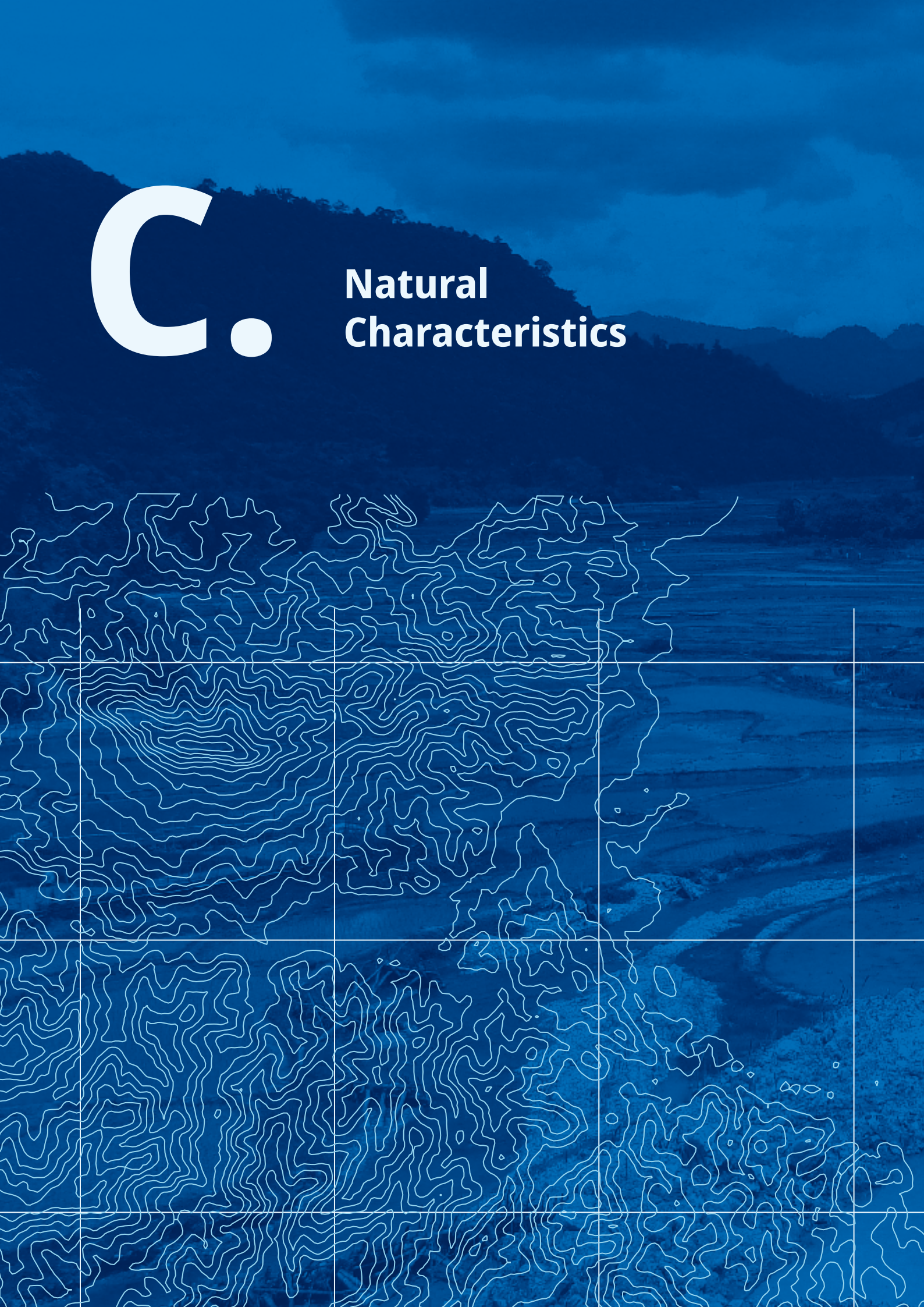
Source: (TUB 2022, adapted from Ministry of Public Works and Transport, 2011)



Legend

- Ancient Place
- Hot springs
- Waterfall
- Ethnic Village
- National Park
- Cultural Place
- Caves
- Province Capital
- District Capital
- Country Boundary
- Province Boundary
- District Boundary
- Airport
- Mainroad
- River

C. Natural Characteristics



Key Messages of Section

Climate change may contribute to increased water scarcity during the dry season and to an increased frequency of heavy weather events that may contribute to increased flood vulnerability.

To ensure the water security of Sam Neua, the **sustainable management of the water catchment** is of strategic interest to the town

Uncontrolled and poorly managed **expansion of agricultural land within the water catchment area**, both by smallholders and by larger agricultural enterprises, can have a significant negative impact on the water resilience of Sam Neua.

To represent a concise overview of the natural characteristics that have an impact on Sam Neua, **the whole catchment area** has to be taken into consideration.

The **narrow topographic surroundings** of Sam Neua are a key factor that is connected to many of the identified challenges the town faces.

Land use and **Land cover** changes in the Nam Xam catchment area around Sam Neua, especially the conversion of forest into grassland and increase of built-up surface, bring significant impacts on water runoff and are a potential driver for an increased flood hazard.

Limited availability of sufficient primary data provides the need to include open-source reanalysis datasets and remote sensing products into the assessment.

Interannual comparison of Temperature and Precipitation patterns indicate strong fluctuation in the previous decade that match predicted **climate change impacts**.

Climate

According to the Köppen-Geiger climate classification, Sam Neua displays a temperate dry winter-hot summer climate (Cwa) (Beck et al., 2018). Laos is subject to two main wind regimes, the northeast and southwest monsoons, with precipitation patterns directly affected by these systems (Kanemaru K. et al., 2014). These are closely related to the Intra-seasonal Oscillation, which is further impacted by El Niño events, and these affect the timing of the beginning of the summer rain season (Zhang et al., 2002).

Local weather data in Sam Neua is collected through a meteorological station (WMO ID = 48928) operated by the Laos Department of Meteorology and Hydrology (DMH) near Sam Neua airport located at 20°25' N 104° 04' E, at an elevation of 1000 m (ADB, 2018; Pathoummady & S., 2010)[1]. Observations from this station extend back to May 2002 and collected data include temperature and precipitation measurements at multiple timescales. Comparative information based on both remote sensing and ground data can be used to derive the required timeframe of 30 years displayed in Figure 20.

Temperature

Figure 21 plots the minimum, maximum and mean daily temperature for each month according to the re-analysis data (ERA-Land 1981–2021). This displays similar trends as the previously used data from the Sam Neua meteorological station between 2002 and 2020. However, as Figure 22 shows, in this timespan the annual mean temperatures fluctuated much more and were often above the long-term average, which could potentially also be attributed to climate change.

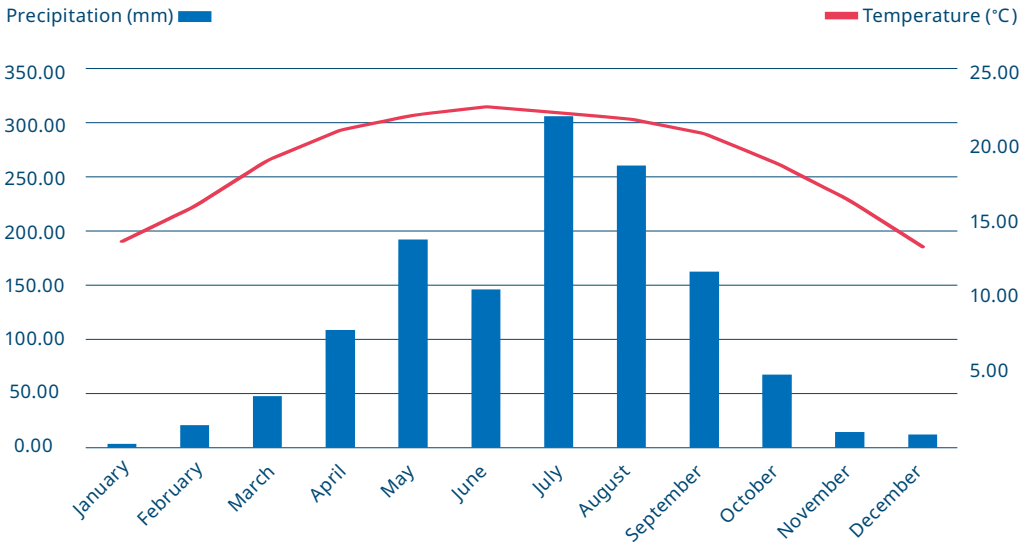
Actual Evapotranspiration (Eta) is a combined term of evaporation (E) from soil, plant surfaces and water bodies, plus the transpiration (T) through plant canopies. The term is useful in the agricultural aspects, where the actual evapotranspiration relates to the Crop Water Requirements. Estimations on the temporal and sptaila distribution in the Nam Xam watershed can be made with the help of satellite-based products, such as GLDAS which was identified to be the most reliable in the region of Southeast Asia.

The temporal analysis spans the years 1981–2021 with monthly mean values ranging 50 to 100 mm and overall annual mean of 929 mm/year. The assessment of spatial distribution analysis indicates higher values in the eastern watershed that increases over the decades. The western part has lower values.

This parameter plays an essential role for the estimation of the water balance of Sam Neua's catchment area, which is introduced later. It indicates how much water is removed from potential use, particularly relevant during the dry season. Through occurring changes in land uses like deforestation and urbanization this parameter changes and can therefore be used as an additional way to monitor the effects of a changing landscape around Sam Neua. Through targeted landscape planning and projects, this loss could be reduced and would provide additional water for the environment, domestic and agricultural users.

Figure 20. Mean climatic parameters in Sam Neua.

Source: (ITT 2022, based on Muñoz Sabater, 2019)



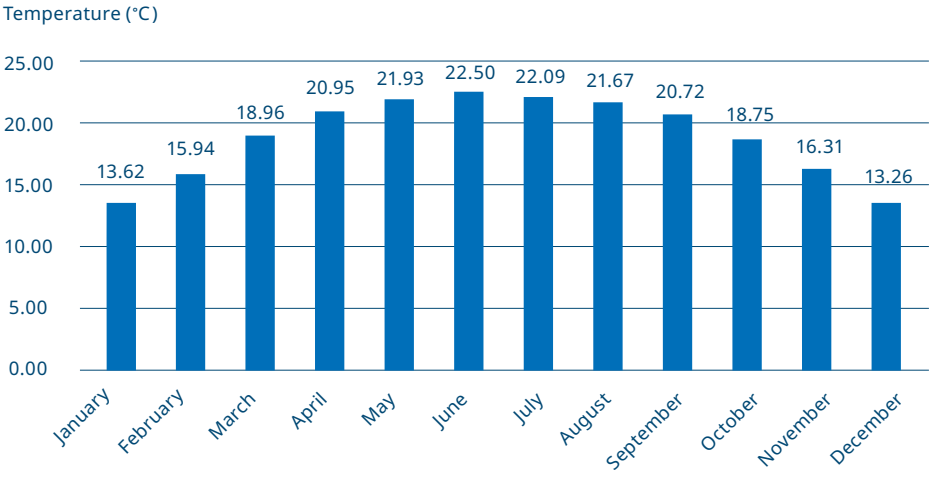
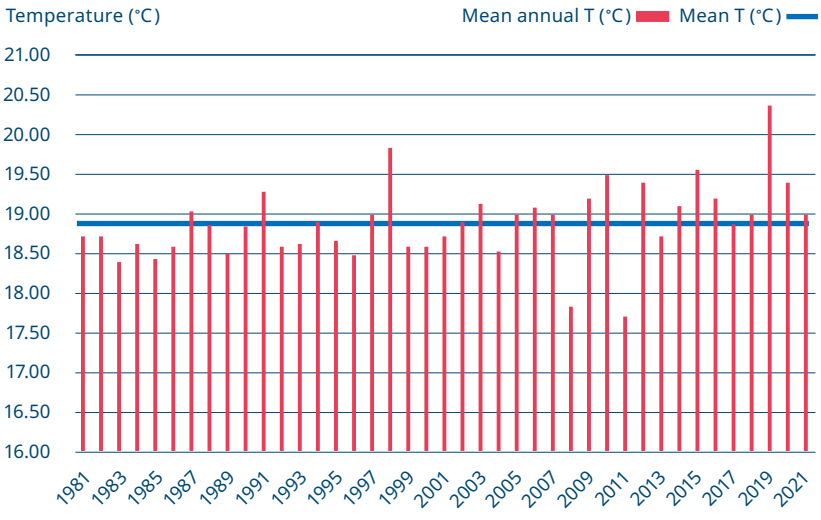


Figure 21. Mean monthly temperatures 1981–2021 in Sam Neua, based ERA5 Land reanalysis data.

Source: (ITT, 2022; based on Muñoz Sabater, 2019)

Figure 22. Mean annual temperatures 1981–2021 in Sam Neua, based ERA5 Land reanalysis data.

Source: (ITT, 2022; based on Muñoz Sabater, 2019)



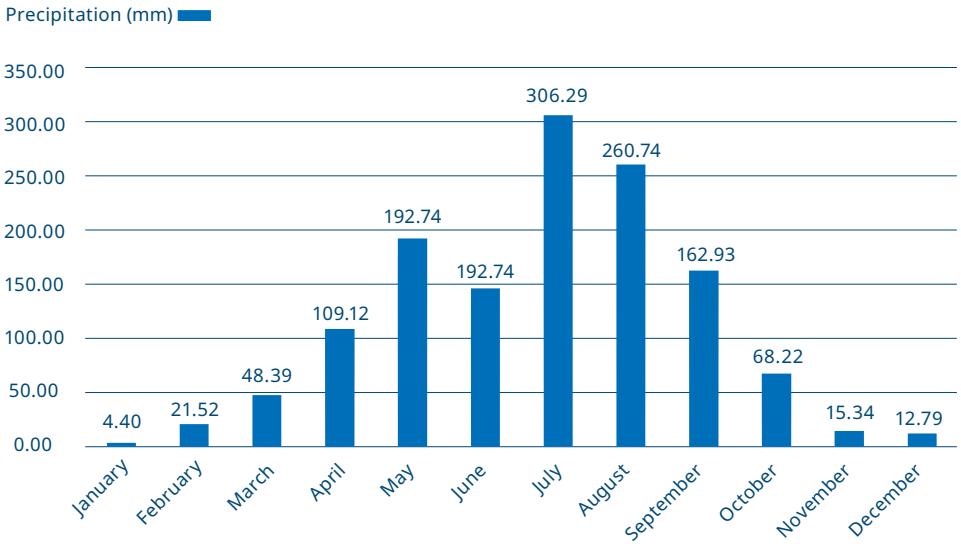


Figure 23. Mean monthly precipitation in Sam Neua between 1981 – 2021

Source: (ITT 2022, based on De Sousa et al., 2020)

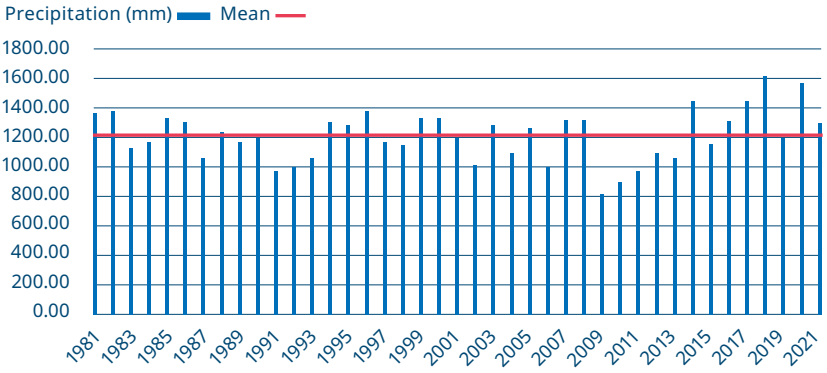
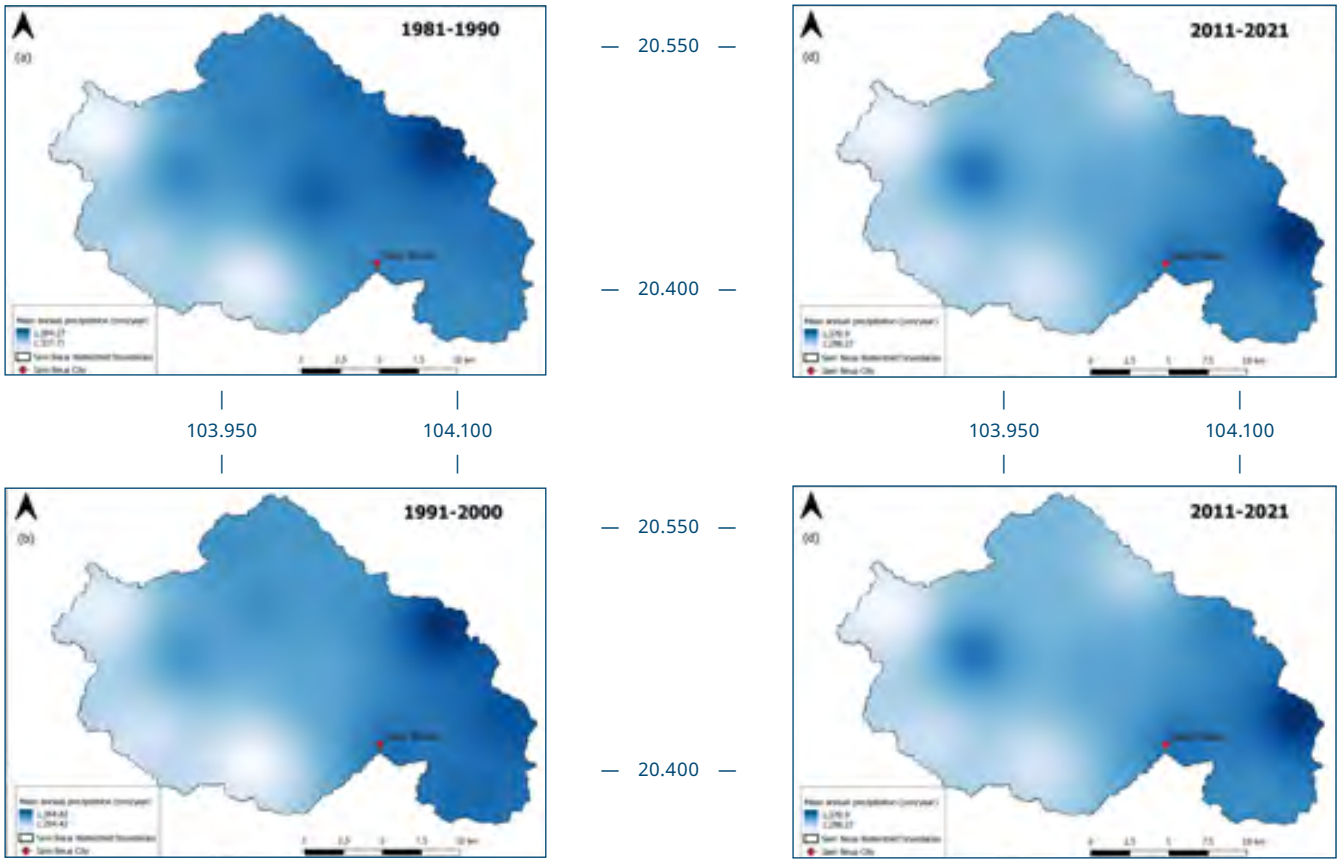


Figure 24. Temporal distribution of mean annual precipitation in Sam Neua between 1981 – 2021

Source: (ITT, 2022, based on De Sousa et al., 2020)



Precipitation

Monthly distribution

The rainy season starts on or from around the 1st April to 31st October (Toda et al., 2004). Figure 23 presents the mean values from satellite-based data between 1981 and 2021, when the two wettest months are July and August (277.50 mm/month and 235.09 mm/month respectively), and the driest months are January and December (4.15 mm/month and 11.52 mm/month respectively).

These measurements show similar trends to the mean values presented in Figure 21 indicating a large variance in total monthly precipitation during the wet season.

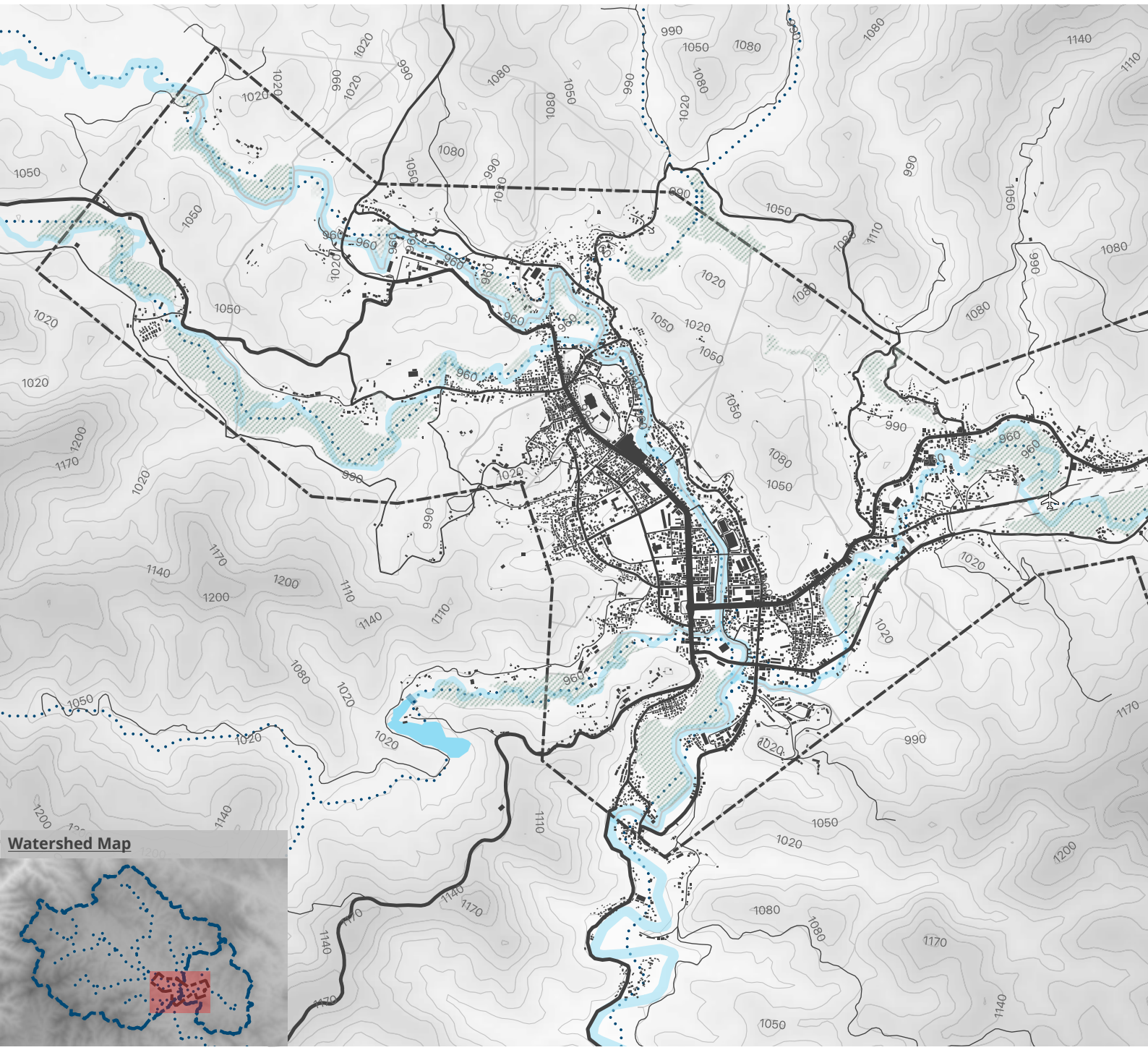
Inter-annual distribution

The mean annual precipitation in Sam Neua between 1981 and 2021 (Figure 25) reaches 1,218 mm/year. During this period, 19 years are slightly above the mean while the two wettest years are in 2018 with 1,624.05 mm and in 2020 with 1,572.28 mm. Peak monthly precipitation over the 41 years of the study period was recorded in August 2018 with 393.94 mm/month, coinciding with a reported flood event. This may indicate an increasing trend in intense rainfall events contributing to increasing the town's flood vulnerability. Nevertheless, to conclude with reliable, scientifically sound statements in this regard, further data series will be necessary for future analysis.

The spatial distribution of precipitation in Sam Neua watershed is represented in Figure 25. The wettest areas are on the east while the driest zones are in the west. This pattern hasn't changed for the past three decades from 1981 to 2010, while in the past decade a slight increase in the central watershed close to Sam Neua town is noticeable. The Sam Neua town is located in the southeast of the watershed in a relatively wet zone, with high precipitation around 1,350 mm/year.

Figure 25. Spatial distribution of precipitation in Sam Neua watershed between: (a) 1981–1990, (b)1991–2000, (c)2001–2010, (d)2011–2021.

Source: (ITT, 2022, based on De Sousa et al., 2020)



Legend

- Airport
- Airports
- Buildings
- RiceFields
- River
- Stream
- Waterbodies
- Planning Area
- Village Boundary
- Watershed delinated - Sam Neua

Road Network

- Road Type 1
- Road Type 2
- Road Type 3
- Road Type 4

Digital Elevation Model

- 940
- 1450

Figure 26. Topography

Source: (generated with QGIS, based on satellite image from Google Earth Pro 7.3.4.8642, 14.02.2020, Sam Neua, Laos, 20°25'1.50"N / 104° 2'52.33"E Eye alt 8.01 km, TU Berlin, 2022)

Climate Change Impacts

The Intergovernmental Panel on Climate Change's (IPCC) regional climate change predictions forecast that during the course of this century, there will be an increase in extreme events and winds in the form of tropical cyclones for Southeast Asia, and they also highlight uncertainties due to the influence of the El Niño–Southern Oscillation (ENSO) (IPCC, 2014). Previous scenarios outlined those temperatures in the region will potentially increase to 2.5 °C, while precipitation in the north-east of Laos will likely decrease by 5 to 10% during the winter (dry season) and increase by 5 to 10% during summer (wet season). The annual mean precipitation is projected to increase by a median change of about 7% in most IPCC A1B Scenario models (Christensen et al., 2007). Furthermore, according to the newest IPCC developed Scenario AR6, annual precipitation is projected to change with a high likelihood of increasingly intense tropical cyclones and an overall negative impact, specifically for agricultural productivity (IPCC, 2022). However, due to Sam Neua's mountainous surroundings, modelling the influences of topography on temperature and precipitation is challenging, and this adds some uncertainty to these predictions. In spite of this, it is highly likely that any increase in extreme events and especially a fluctuation in the onset of the wet season will impact a rural population reliant on agricultural food production for their livelihoods (Ingxay et al., 2015).

Topography

Figure 26 outlines the topographical surroundings of Sam Neua and the watersheds corresponding to the main Xam and Xim Rivers (delineated from (Earth data, n.d.) together forming the headwaters of the Nam Xam River. The catchment elevation ranges from 937 to 1206 metres above sea level. The valleys surrounding the town indicate fluvial origin with many small side arms and are part of the Truongson Belt and a northern extension of the Annamite Range of mountains (Hou et al., 2019).

The urban area of Sam Neua town is surrounded by valleys, and so due to this topography, it is more vulnerable to flooding during heavy rainfall as surface runoff from the hills flows towards the urban areas. For example, Figure 27 illustrates how even if the spaces for infiltration continue to decrease, water will still continue to flow down into the town but will be unable to infiltrate away and cumulate in the lower located areas causing more flood events.

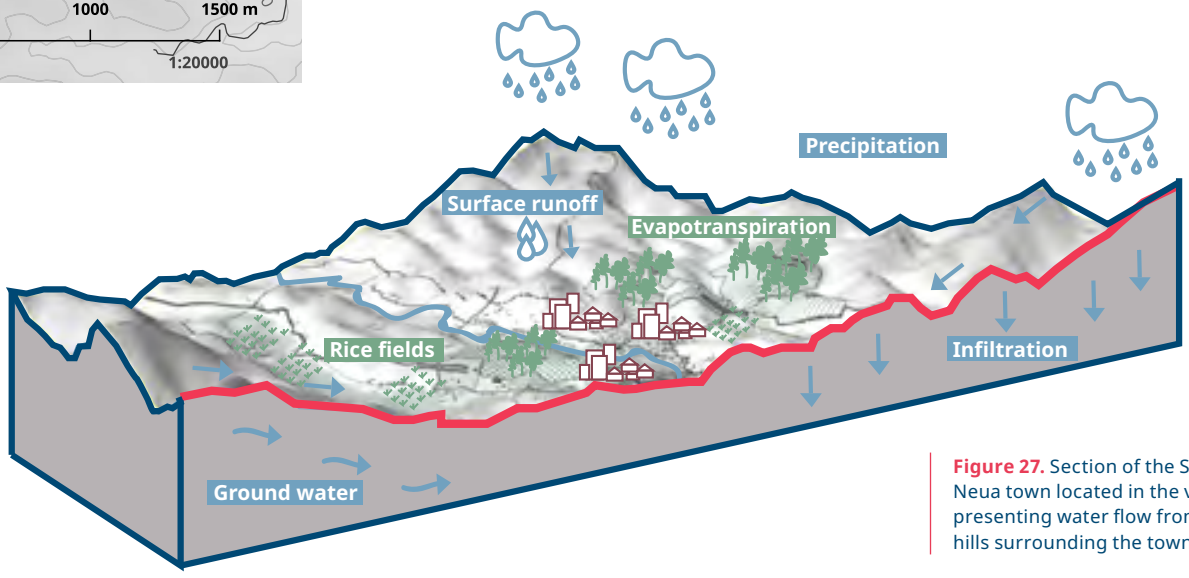


Figure 27. Section of the Sam Neua town located in the valley, presenting water flow from the hills surrounding the town.

Hydrology and Water Resources

Geological formation

Geologically, Sam Neua is situated in the Indochina block (or Truongson belt part) of the so-called Sam Neua Suite. Rock material found in the sub-suite indicates Cambrian rock of metamorphized origin, dominanted sand- and siltstone, as well as shale and marine conglomerates (Hou et al., 2019; Miyahigashi et al., 2017). Soil formation on this type of geology is characterized by quick weathering in tropical climates. Soils found in these conditions are typically Acrisols, which display high clay content and acidic pH levels, as well as low humus content. Potential threats are surface hardening and declining soil nutrition (Zech & Hintermaier-Erhard, 2002).

Estimates assume that Laos' aquifers formed from Schist material are shallow and have a very low storage potential (Viossanges et al., 2018). On the other hand, Mesozoic sediment rocks in Laos have significant storage capacity. They have an especially high-water storage potential due to their thickness and widespread distribution, but vary greatly in their individual productivity. It is estimated that they store around 58% of Laos' shallow groundwater and already provide water for domestic purposes (Lacombe et al., 2017; Viossanges et al., 2018).

According to WEPA (2021), research from the Interim Mekong Committee separates Laos in the Annamian Strata to the North and East while Indosinian sediments are present along the Mekong River. These include different aquifers: local surface-fed with potentially high recharge rates in the north of the country (Annamian aquifers) and local surface fed with potentially high recharge rates in the north of the country (Annamian aquifers), young Moyennes and Superieurs freshwater sedimentary rock with brackish water (Indoisian aquifers) to the east of the country. Additionally, sediments from the Mekong River form sedimentary deposits (WEPA, 2021b).

Surface water

Sam Neua is rich in surface water resources. The town territory is crossed by the Nam Xam River, which remains the main water body in the town. The Nam Xam River originates at Houa Peak near the Sam Neua urban area and enters the town of Sam Neua from the north-west to south-east at a length of 37 km. After the river passes through the town of Sam Neua, it flows east to meander through Phoxay, Thatmeaung, Nathogjong, Misouk, Navieng, Nnaongbua, and Nathong/Phonekam villages draining away the east into Vietnam, eventually flowing into the Ma River before discharging into the sea (ADB, 2018; Lehner & Grill, 2013). It has a total catchment area of 7,715 km² of which 428.5 km² are located upstream of Sam Neua and a total length of 325 km.

Due to the lack of time series discharge data in Nan Xam basin, an equation of a simplified global water balance was used to estimate the yearly discharge of surface. As a spatial outline for this analysis, the delineated watersheds of the Nam Xim downstream of Sam Neua town has been applied. An estimation of the natural water discharge (Q) in the Nam Xam watershed is based on mean precipitation (P) and actual evapotranspiration (ETa) values from the years 1981 to 2021:

$$P - ETa = Q$$

$$1{,}348.95\ \frac{mm}{year} - 929.39\ \frac{mm}{year} = 419.56\ \frac{mm}{year} \text{ or } 5.59\ \frac{m^3}{s} \text{ or } 482{,}976\ \frac{m^3}{d}$$

This calculation gives an approximate estimation, but also has certain limitations, as it does not take into consideration water infiltration rates and water diverted from the river for other uses. However, one single measurement flow estimations exists for the Xam River, taken at the main water stream near Ban Ngew weir, upstream of Sam Neua town (See Figure 61 for the Water Supply Map). These surface water discharge calculations are based on the measurement of the head over the diversion weir and calculated to be 90,000 m^3/d during the dry season and 170,000 m^3/d during the wet season. The exact method of calculation, context of these measurement and the specific location are not reported (ADB, 2018). It has to be mentioned that this information is not suitable for water management purposes, because longer time series are needed in order to ensure fact-based decision making, which is the benefit of a satellite-based water balance. The difference between the first calculation above mentioned measurment are related to the fact that downstream of the Ban Ngew weir, several other streams join the main river, infiltration rates and water is diverted for domestic and agricultural uses, which are unidentified for the larger watershed.

Groundwater

With the impacts from urbanisation and climate change associated with a higher water demand, the town's residents may come to depend on groundwater resources for their water supply more than they currently are.

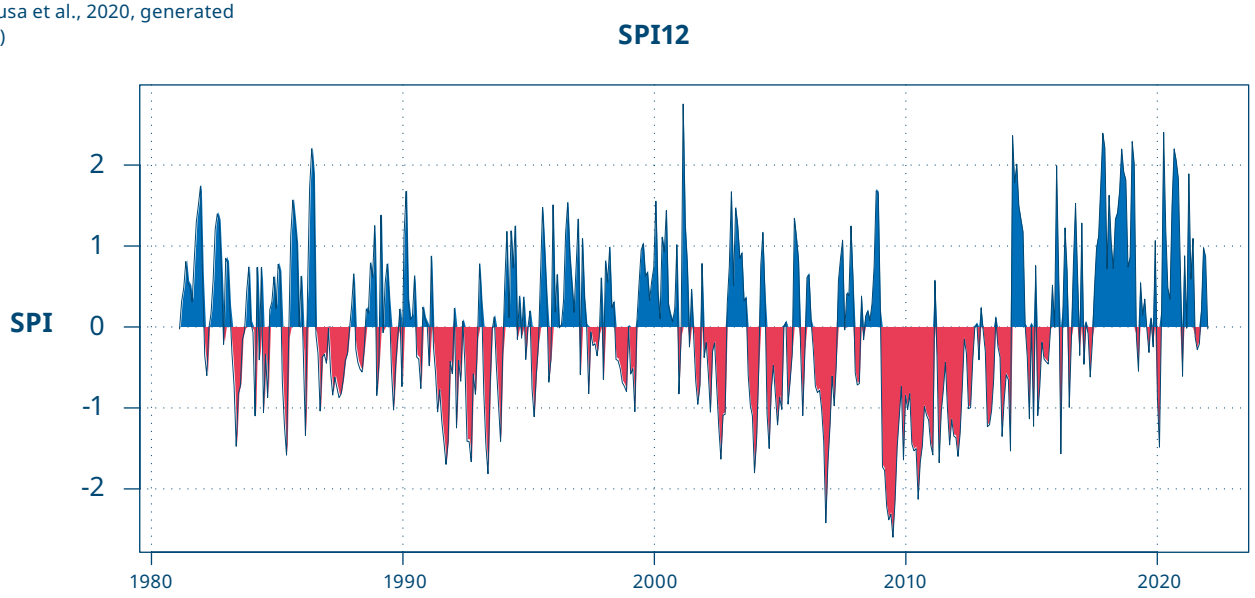
The main groundwater unit in Sam Neua is Sedimentary Mesozoic under the hydrogeological group of basement and bedrock. The theoretical calculated results of the aquifer unit in Sam Neua were calculated as follows: the expected discharge is around 0.1–1.5 L/sec, the groundwater storage is calculated to be around 2400 mm, considering a 30m aquifer thickness, and the annual groundwater recharge value is around 190 mm/year (Viossanges et al., 2018).

Reliable data are necessary for the sustainable management of these water resources. They are a prerequisite for an understanding of the major aquifer units, along with the quantitative aquifer indicators. However, currently there is a lack of data from nationwide assessments of shallow (<30 m) groundwater resources to support sustainable management (Viossanges et al., 2018).

According to the local district government of Sam Neua, there has been no official groundwater investigation in the town area (ADB, 2018). According to the DoNRE, there are plans to establish a groundwater monitoring system.

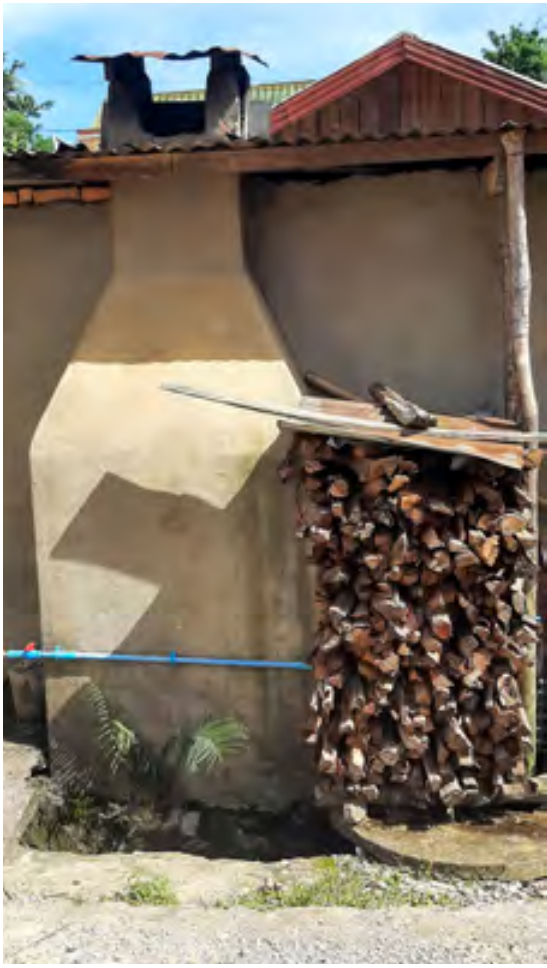
Figure 28. SPI values in Sam Neua between 1981 – 2021

Source: (ITT 2022, based on De Sousa et al., 2020, generated with R)



Droughts

Drought-like conditions have been reported in Sam Neua town in previous years and even led to technical changes in the ADB led water supply system upgrade (ADB, 2021). Interannual variation of meteorological drought can be assessed through the application of indicators, such as the Standard Precipitation Index (SPI). For the case of Sam Neua, Figure 28 is based on satellite data (CHIRPS) and shows the monthly SPI calculations in the study region over the period 1981 – 2021 with a positive value indicating wet conditions in the respective year (see EU 2020). Specific periods with dry conditions have occured in exchange for regular wet annual conditions between 1980 and 2010. Of note is that in the period between 2010 and 2015, a specifically long and strong period of drought occured, with an extreme drought event (SPI >-2) from 2009 to 2010. In contrast to that, more recent years have witnessed particularly wet months. This indicates specifically strong variances in extreme conditions.



Vegetation Types and Landcover Change within the Water Catchment Area

Over the past decades, development in Laos has resulted in the reduction of natural forests at an annual rate of 1.24 %. This has caused the degradation of grasslands and shrublands, as well as the transformation of natural forests into plantation forests and croplands. As a result, ecological fragmentation has occured, especially on slopes in higher altitudes. These changes can generate an increased surface runoff and further soil degradation threating biodiversity (Wang et al., 2019).

Nationwide trends in changes to land cover also apply to Sam Neua. Overcutting and removal of trees have a direct impact on water storage capacities and protection while shifting agriculture and shorter growing cycles exhaust the soil and more rapidly reduce productivity. Due to Sam Neua's notable reliance on natural resources and the impact that humans have on the environment, the interaction between social and ecological drivers is particularly important. Existing pressures include (but are not limited to) shifting agriculture patterns, unplanned logging, and uncontrolled hunting (ADB, 2018). Importantly, the predominant cooking fuel in the province is fuel wood for 95.8 % of the population exacerbating deforestation further (Lao Statistics Bureau (LSB), 2015), p.97).

According to the ADB, (2009, p.17), the steep mountainous slopes in the province "with their moderately thin layers of soils are particularly prone to erosion when vegetation is removed, and soils are exposed to rainfall and surface water flows. Thus, water quality in the mountain streams and rivers can be rapidly degraded when soils are eroded and flushed into them which results in increased turbidity that reduces water quality for aquatic life and domestic and livestock consumption".

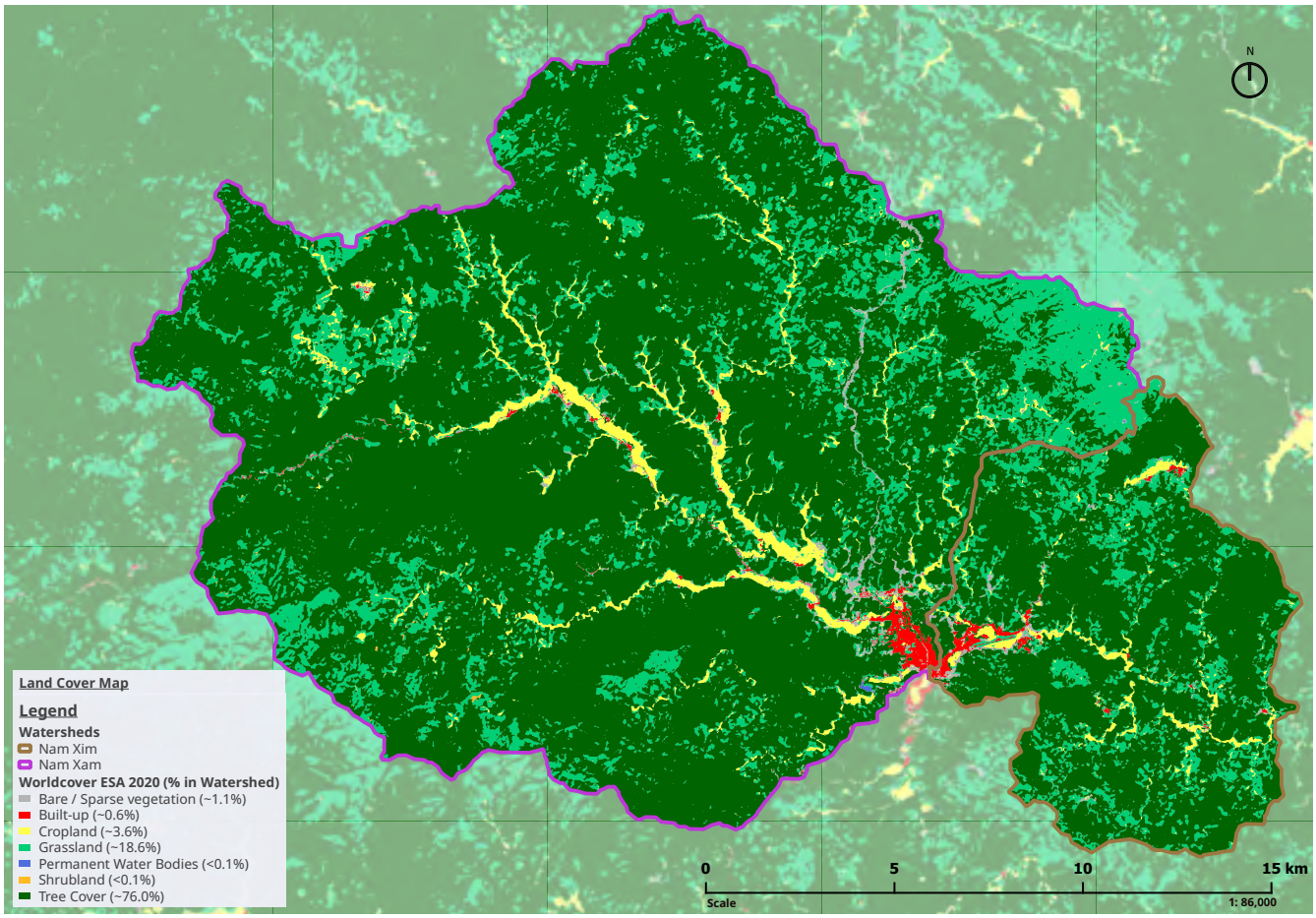
Figure 31 outlines the land cover patterns and their respective shares around Sam Neua in 2020, as well as showing the delineated catchments corresponding to the rivers that flow through the town. The total area of the identified land cover type in the catchment area are: Tree Cover = ca. 318km^2 (76 %), Grassland ca. 78 km (18.5 %), Cropland = ca.15 km^2 (3.5 %) Bare = ca. 5 km^2 (1 %), Built-up = 3 km^2 (0.6 %) and Water bodies / Shrubland < 1 km^2. In comparison to previously analysed data in 2018, this corresponds to a decrease in Tree Cover of 2.5 %, an increase of Grassland by ca. 10 %, a tripling of Bare land surfaces and a doubling of the Built—up area (SERVIR Mekong, n.d.; Zanaga et al., 2021). These changes highlight how deforestation and urbanization in the watershed around Sam Neua are occurring with dramatic speed.

Figure 29. Left: Fuel wood for cooking as the predominant cooking fuel sourced locally; Right: Example of deforestation in Sam Neua´s urban extension area.

Source: (TU Berlin, 2022), (Google Earth Pro 7.3.4.8573 (2/14/2020). Sam Neua, Laos. Coordinates 20°25'34.21"N, 104° 01'17.55"E, Eye alt 1.03km).

Figure 30. Land cover around Sam Neua.

Source: (Earthdata – SRTM, n.d.; © ESA WorldCover project 2020 / Contains modified Copernicus Sentinel data (2020) processed by ESA WorldCover consortium, generated with QGIS, ITT, 2022)



A further example of the current change dynamics was captured during a drone flight in June 2022 in the urban extension area of Naliew village as presented in Figure 31. In the orthomosaicked images, a current development zone, a burned forest plot and future building plots (see Figure 32) can be identified, with slim vegtation stips along the slopes and river, as well as agricultural area and ponds. Most of these land uses changes took place in the previous 6 years, according to satellite image archive assessments (© CNES / Airbus accessed via Google Earth).

Drone images can further be used to generate vegetation indices (Louhaichi et al., 2001) that are useful to identify vegetation corridors, bare surfaces and buildings, as introduced in Figure 32.

Local authorities list three different categories of land use zones (Development, Conservation, and Protected) that are further divided into 29 individual sub-zones (DoNRE, 2018).

According to the extension District Office for Agriculture and Forestry, Sam Neua District is covered by 93,156 ha of forest including two national and one district protected/ conservation areas (located near Ban Nathong Village) and 59 village ones. In addition, four National Protection Forests for water source protection areas and 49 aquatic resource protection zones are mentioned. Protected areas in the larger surroundings of the town include the Nam Xam National Biodiversity Protected Area (NBCA) and Nam Et (NBCA) (ADB, 2018).

Figure 31. Land cover change dynamics, captured by drone

Source: (ITT, 2022)

Productive forest is estimated at ca. 47 ha, while ca 6 ha are defined as rehabilitation forest. Furthermore, there are commercial tree plantations to be found in the district.

Agricultural cropland is found in the valley floors along the local river networks and near the urbanized town centre, which lies at the confluence of the Xam and the Xim Rivers. For information on land cover at the national level, the reader is referred to Wang et al., 2019.

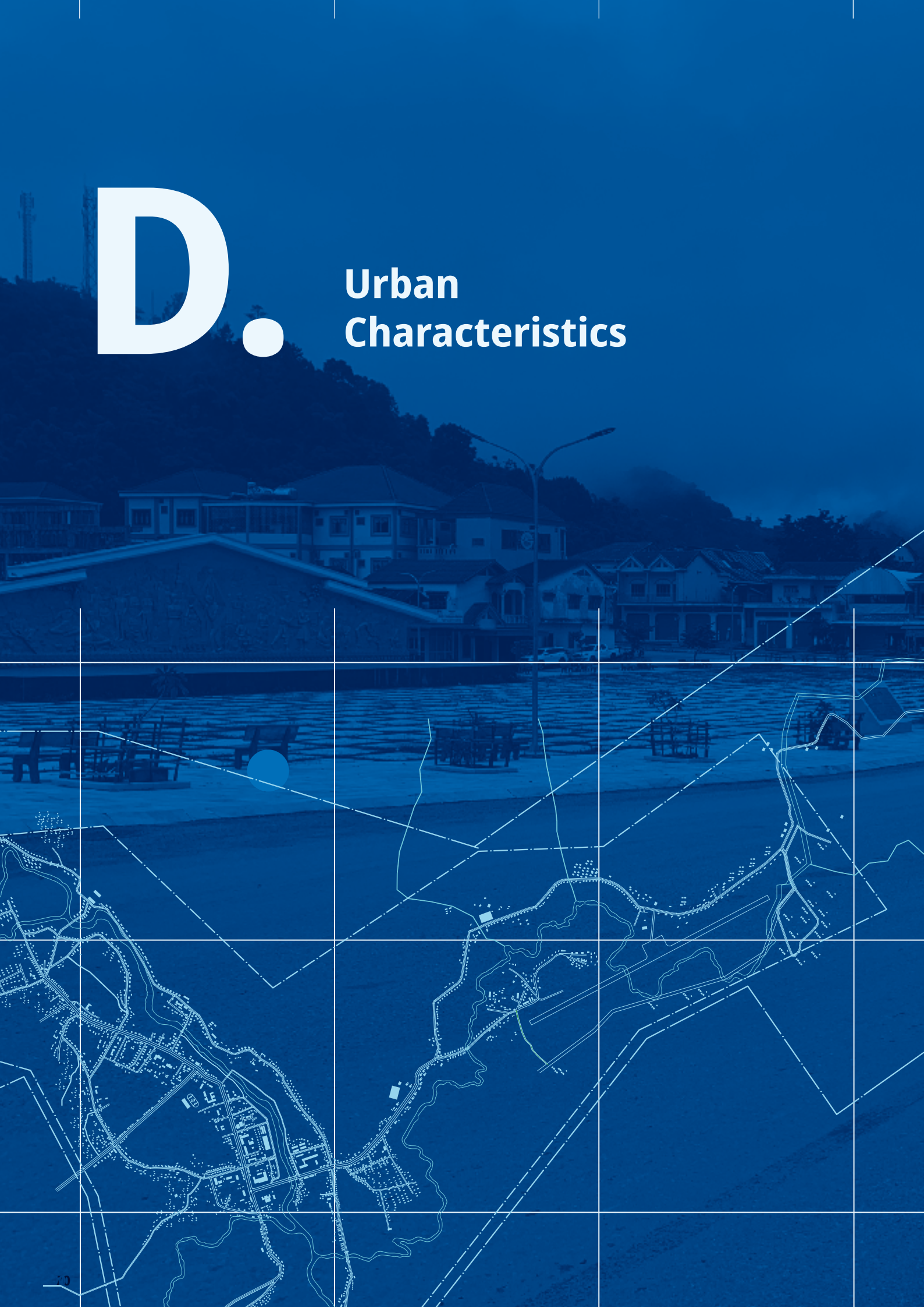
Previous assessments report a history of swidden agriculture (otherwise known as shifting cultivation), as well as logging of the hillside forests around Sam Neua. Riparian buffer strips along the local rivers are used for urban development and have gradually replaced the rice paddy fields there (ADB, 2018).

Studies in the neighbouring Hua Meuang District (also located in Houaphan Province) have indicated the cultivation and expansion of the production of cash crops, which are driven by policies that stimulate foreign investments (Vongvisouk et al., 2016) resulting in maize replacing upland rice farming. Rotation periods for upland rice span over 7 years or more while cycles for maize are only 2 to 4 years, and this is driving the replacement of natural forest areas.

Figure 32. Vegetation Index captured by drone

Source: (ITT, 2022)

D. Urban Characteristics



Key Messages of Section

Despite the COVID-19 pandemic, there is currently a highly visible **construction boom** of medium to higher-end residential real estate throughout the town, as well as a new large-scale hospital building and government administrative buildings.

In extension areas and within the urban planning area, remaining **agricultural land is gradually being converted to settlement land** for construction without consideration for the impacts on the hydrological system.

Vertical urban growth in inner areas offers effective and efficient use of the limited urban space. However, larger scale **multi-story development is occurring at a very low rate**, currently limited to government administrative buildings, the new hospital, and several hotels.

Development follows new roads: urban expansion areas are already playing a vital role in accommodating urban growth. The prevailing planning and development approach in these areas has been to simply **build new roads in the area to create access with the expectation that individual land-owners in the area will further develop their own plots.**

New properties (mostly residential) are being **developed randomly along the roads** and layouts are designed arbitrarily according to individual property owners' own concepts and decisions. For the most part, the new land-use of a development is also decided arbitrarily by the land-owner, rather than strategically pre-designated by a local area plan.

It is common practice throughout the town for properties of **all types to have all or most of their surfaces** sealed with concrete, leaving little or no unsealed areas for infiltration. Runoff is discharged to drainage networks, if available, and eventually local surface waters. An urban heat island effect is a likely result.

Land available in suitable locations for construction and spatial expansion is **decreasing** and has become **limited to more precarious locations** in the town. Developments increasingly take place in existing and potential **flood prone zones**, at steep roadside terrain and without sufficient stabilization and foundation soil. **National and international land development standards** should be followed.

Many areas of the town have **good proximity to green and/or blue areas** (rivers, ponds, wetlands, forests), which can potentially be integrated into water-sensitive urban planning solutions.

Land Uses, Zoning, Protected Areas and Villages

For the purposes of urban planning and administration, the urban area, Sam Neua town, comprises an agglomeration of 12 villages out of the 103 villages in Sam Neua District, with a total urban planning administrative area of approximately 1,416 hectares (Figure 33). Sam Neua is classified in the Lao PDR planning system under "cities and municipalities belonging to districts" with two formal areas, namely the town centre and expansion areas. The town centre maintains commercial, service and business land uses, but not industrial. Primary land uses include residential construction, commercial places, services and office buildings, and others zoned according to the following categories: Central Zone (UA); Business Zone (UB); Community Zone / Suburb (UC) Airport Zone (A); Agriculture and Forest Zone (NC); Extension Area (NA); Possible Building Area. The area for the town's expansion has been allocated to allow expansion, population growth, and socio-economic activities for mixed land uses including residential, educational, airport, commercial, services, handicrafts, Level I industries, transportation, and land for agriculture, forests for recreation and tourism, among others.

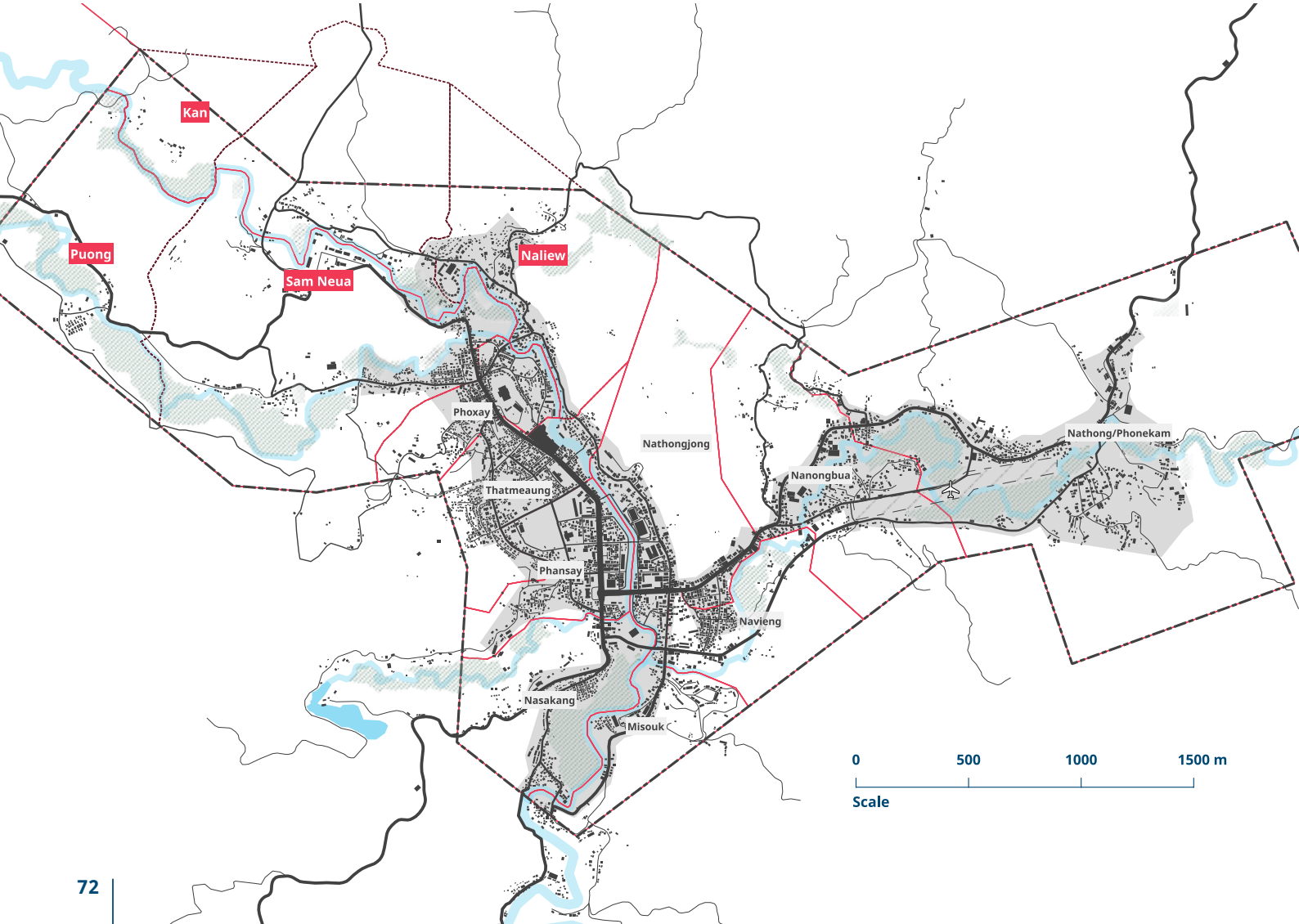


Figure 33. Map: Sam Neua's urban planning area.

Source: (generated with QGIS, based on satellite image from Google Earth Pro 7.3.4.8642, 14.02.2020, Sam Neua, Laos, 20°25'1.50"N / 104° 2'52.33"E Eye alt 8.01 km, TUB, 2022)

Figure 34. Urban Master Plan Zoning Scheme for Sam Neua.

Source: (Ministry of Public Works and Transport, 2011

Land Conversion for Urban Development

According to Sam Neua's Master Plan (2011), there is **"limited area for development",** as a result agricultural and forest land is gradually **being converted to urban area** (Figure 35). Given the current rate of expansion, by 2031 the estimated "sealed area" (constructed area) will have increased from 17% in 2011 to 38% (linear growth scenario) and green area (forest, agricultural land and public park) will have decreased by 35%. Sam Neua's extension area contains strongly undulating land formations, mixed between high and low elevation with limited area for urban development. The predominant land uses are agricultural and/or forest. Agricultural land is used primarily for rice paddy fields. As per the 2011 Master Plan, urban growth in the extension areas normally requires excavation of terrain and conversion of these rice paddies.

Surface Area Change between 2011–2031 in Sam Neua

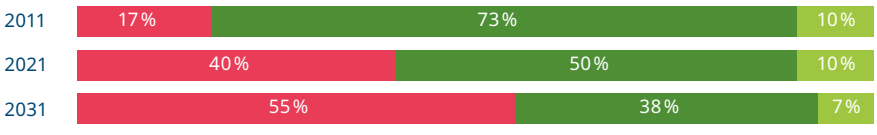


Figure 35. Loss of green space and increase of sealed (to 2031 linear prediction)

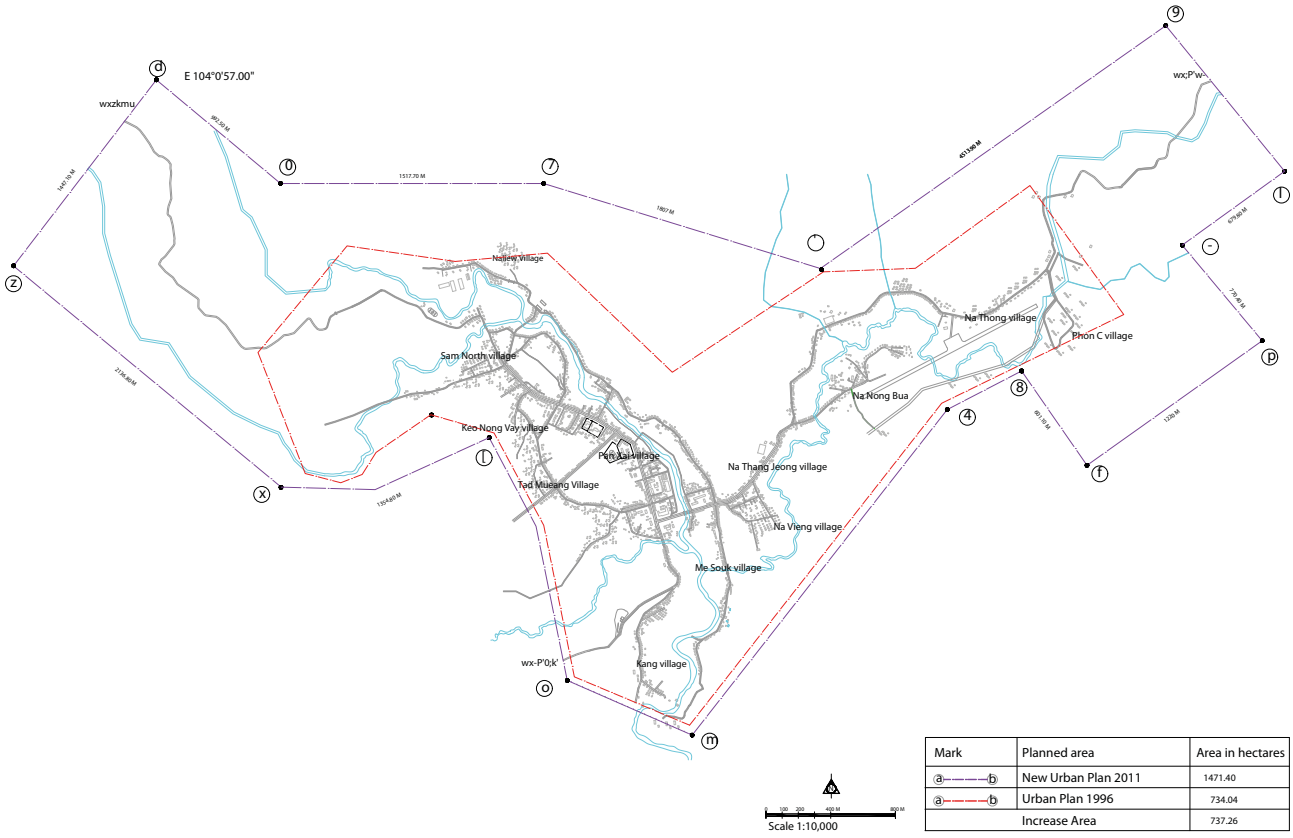
Source: (TU Berlin, 2022)

Urban Growth/ Transformation and Development Practices

Sam Neua town area has been growing steadily over the last 30 years, transforming from a small, agriculture based rural town to a larger, more significant, and complex provincial center. This substantial transformation and growth of the urban planning area is evident in the photo comparison (Figure 36) as well as in the 1996 (red border) and 2011 (purple border) urban boundary shown in Figure 37 – with an area increase of 736.26 ha. Clearly visible is the conversion of land in the town's central areas, indicating that Sam Neua **has already begun the transition from a small, rural town dominated by rice paddies to a more modern, ambitious capital,** with upgraded built forms, such as numerous new public administration buildings, hotels, and guest houses, revitalized public spaces, and a new fresh produce market amongst other shopping facilities.

Figure 36. Images of Sam Neua town´s urban core showing 19-year transformation of the town between 2003 and 2022, from a strongly rural character dominated by wet rice paddy cultivation (top photo) to a more significant and developed provincial town (bottom aerial image)

(Top photo: Source, Chittavahn Hotel Sam Neua, 2003. Bottom image: Source Google Earth Pro 7.3.4.8642, 14.02.2020, Sam Neua, Laos, 20°25'1.05"N / 104° 2'52.41"E Eye alt 1.36 km,)



Mark	Planned area	Area in hectares
a — b	New Urban Plan 2011	1471.40
a - - b	Urban Plan 1996	734.04
	Increase Area	737.26

Figure 37. Urban Planning area expansion from 1996 (red border) to 2011 (purple border).

Source: (Ministry of Public Works and Transport, 2011)

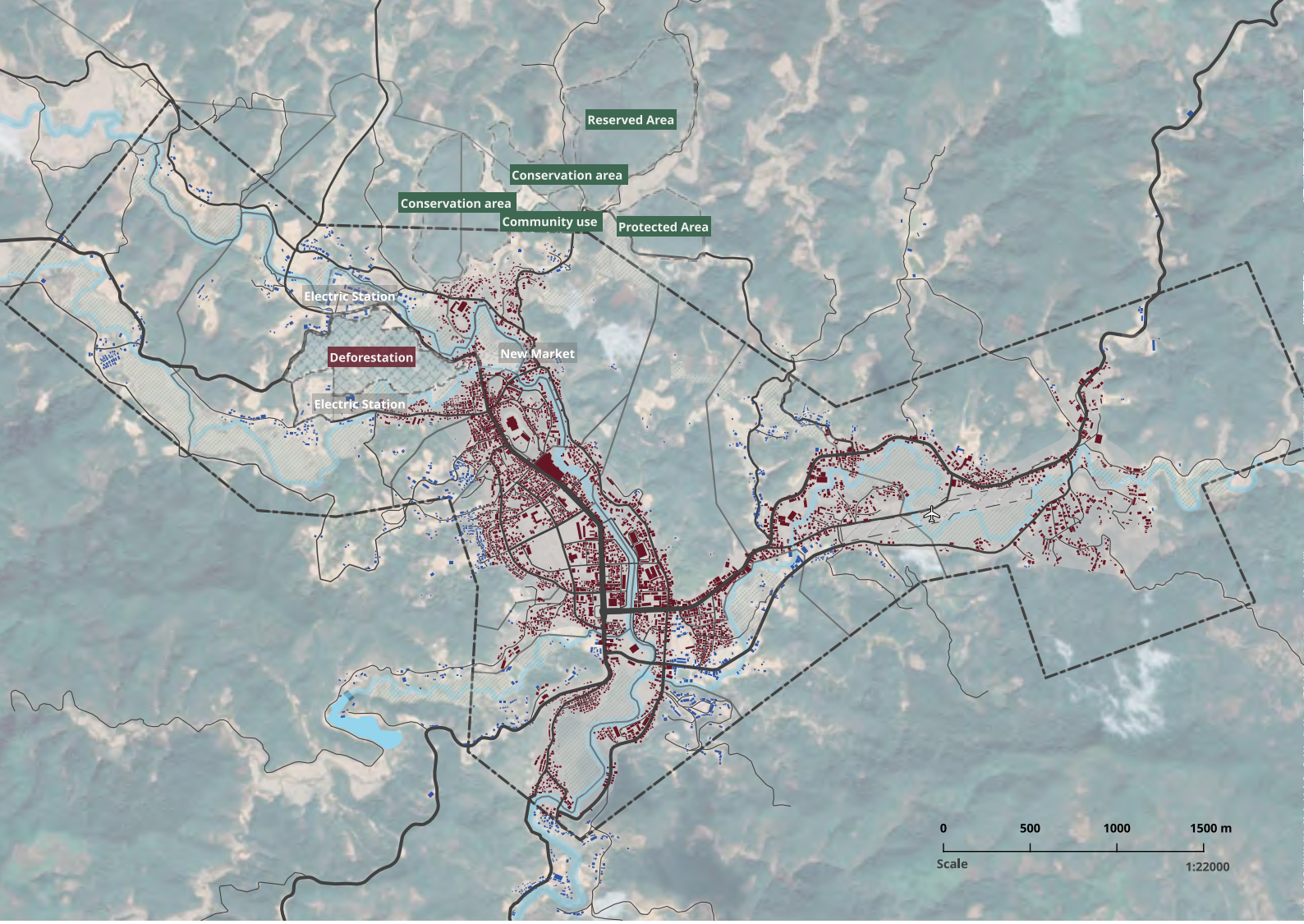
Urban Expansion Process: Development Follows New Main Road Infrastructure

In general, urban growth is **occurring horizontally** mainly along dedicated growth corridors (zoned "Urban Extension Area") with newly built main roads following river valleys that fan out to the west and north (towards the new airport in Ban Nong) from the town's center. The extension areas in the west comprise the villages of Ban Naliev, Ban Sam Neua, Ban Phoung and Ban Koh. To a lesser extent, extension areas are also located in the east and located within the villages of Ban Misouk, Ban Navieng and Ban Nathong. Vertical built expansion is occurring at a **much lower rate** and is usually limited to larger buildings, such as the new hospital, new government offices, and some hotels.

The map below (Figure 38), shows the growth pattern over the last 10 years – a comparison of settlements in 2011 and in 2021 is presented.

There are no formal urban layout plans nor specific urban planning processes for the development of the extension area. To generate new urban development in the urban expansion area in the west and north of the town, new sealed main roads have been built during the last decade, where previously there was limited or no access to the area. New urban development here has quickly ensued as evidenced by the satellite time series sequence below. Overall, development normally occurs randomly, adjacent to or close to the road according to the needs of the various individual property owners. New properties (mostly residential) are being **developed randomly along the roads** and layouts are **designed arbitrarily according to individual property owners' own concepts and decisions.** For the most part, the new land-use of a development is also decided arbitrarily by the landowner, rather than strategically pre-designated by a local area plan.

The area along the main roads and the Nam Xam River, located in the northwest part of Sam Neua (Figure 39) can be considered one of the main growth corridors of the town (Figure 40).



Urban Growth Map

Figure 38. Sam Neua's growth patterns.

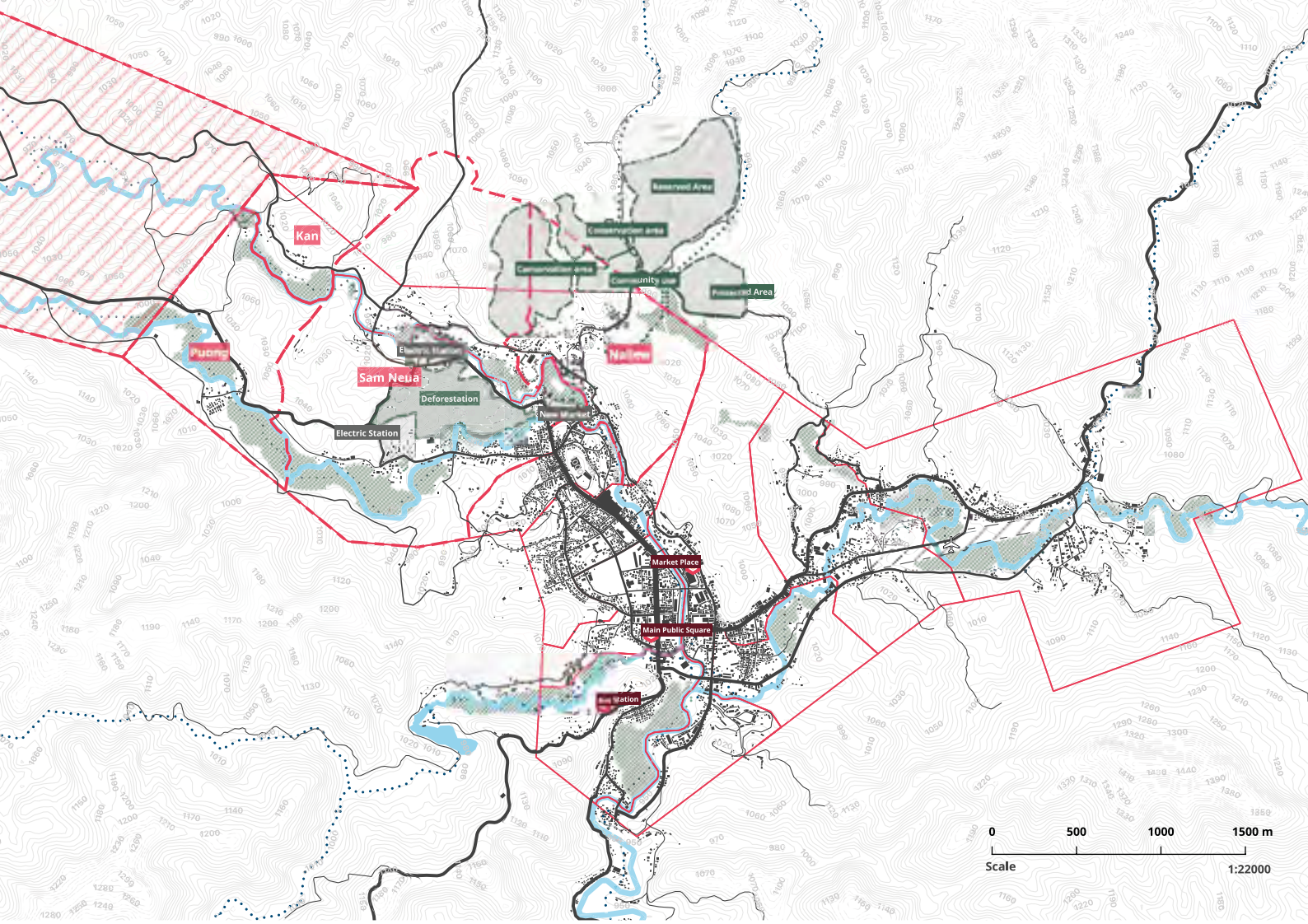
Source: (generated with QGIS, based on satellite image from Google Earth Pro 7.3.4.8642, 14.02.2020, Sam Neua, Laos, 20°25'1.50"N / 104° 2'52.33"E Eye alt 8.01 km, TUB 2022)

Legend

- Airport_point
- Airports
- Goverment Land
- Village Land
- Deforestation
- Rice Fields
- 2011
- 2012
- Road Type 1
- Road Type 1
- Road Type 1
- Road Type 1
- Other
- Planning Area
- Village Boundry
- River
- Stream
- Water Bodies
- Building Area till 2011

Figure 39. New roads built along the course of the urban extension area have opened up the previously low access area for new urban development in various locations, however not following any formal planning process.

Source: (Google Earth Pro 7.3.4.8573 (2/14/2020). Sam Neua, Laos. Coordinates 20°24'40.59"N, 104° 2'59.35"E, Eye alt 3.75km)



Growth Corridor Map

Figure 40. Sam Neua's town growth corridor.

Source: (generated with QGIS, based on satellite image from Google Earth Pro 7.3.4.8642, 14.02.2020, Sam Neua, Laos, 20°25'1.50"N / 104° 2'52.33"E Eye alt 8.01 km, TUB 2022)

Legend

- Airport
- Airport Area
- Buildings
- Landmarks
- Road Type 1
- Road Type 2
- Road Type 3
- Landmarks
- Rice Fields
- River
- Stream
- Waterbodies
- Village Boundary
- Village Boundary (updated as per workshop in 07.22)
- Growth Corridor
- Watershed delinated – Sam Neua
- Elevation Lines every 10 min
- Village land (as per workshop in 07.22)
- Deforestation / New Agriculture Area (as per workshop 07.22)
- Goverment Land (as per workshop in 07.22)

Figure 41. Construction boom of residential properties taking place throughout the town

Source: (TUB, 2022)

New Construction: Medium to Higher-End Real Estate

Over the last few years, it is evident Sam Neua has undergone and is still currently undergoing a *construction boom* despite the COVID-19 pandemic. This is evidenced throughout the town by a proliferation of construction sites and newly finished buildings (Figure 41), notably medium to high quality private residential properties and guesthouses but also government buildings, a new hospital, and public parks. Constructions are typically of good quality building materials (brick, steel, concrete, roofing tiles) and often multi-story (usually two, and sometimes three stories). Construction activity is being undertaken by mainly private individuals and international groups from neighboring countries. A common scenario is for Lao PDR nationals based in the capital, who have ties to Sam Neua and/or the economic means, to build as an investment for their future living arrangements, such as retirement.

Water in the Town – Story 2:
Local Authority Planning and Management

During conversations with local stakeholders, there were predictions that within 10 to 15 years all areas that are currently rice paddy could be covered/filled and that all waste water would be discharged into the Nam Xam River if no other management method was implemented. The stakeholders discussed how there is no long-term plan to manage water in the event that Sam Neua Village continues to be developed in the current manner as the local government have no legal right to tell people how to develop their properties. However, there is evidence of local management efforts as local residents are not allowed to build their houses within 10 to 20 metres of the river and those houses causing pollution are warned and encouraged to manage their waste better. Moreover, the local government describe how the wastewater has standard discharge parameters, but they lack the capacity to effectively monitor these, and while the ADB has a protection plan for the water supply intake point, the local authority points out that the recommendations are not followed by the local residents. (UDAA Meeting Notes, BORDA 2022)

Figure 42. Examples of construction in vulnerable construction locations throughout Sam Neua
Source: (TUB, 2022)

Limited Urban Space Forces Building in Vulnerable, Risky Locations

Due to the very limited space for new building in the town, new plots are often created and built in vulnerable, unsafe locations (steep mountainsides, cut slopes, riverbanks and converted rice paddy fields) with greater exposure to the climate change induced risks of mud-slides and flooding (Figure 43).

Creation of New Building Area via an Unregulated "*Cut and Fill*"

Practice

To create space (new land to build on), an unregulated yet very common practice of *"cut and fill"* is adopted whereby immense volumes of soil are excavated (*cut*) from local mountainside sites by a local private excavation contractor and is used to *fill* in rice paddy agricultural lands, which is then compacted and constructed on (Figure 44). The recent second phase of extension area development has seen the conversion of rice paddy areas in Sam Neua Village, Navieng Village, Phon Kham Village and along the road from Nathong Village to Naliew Village (Figure 44, Figure 45 and Figure 46). The practice is not without **risks** as **evidenced by numerous public and private buildings having already experienced structural damage** and/or tilting due to the instability of the filled soil. According to the DPWT, the integrity of the newly filled/converted area relies on the experience of the private contractor in compacting the filled soil. In cases where such issues become evident during construction, such as expanding cracks, construction is stopped.

Figure 43. Practice of cut and fill is used to create new land for construction in new extension area of Naliew with examples of new areas created with housing and main road

Source: (TUB, 2022)

Figure 44. Newly converted and built over paddy field in central area

Source: (TUB, 2022)

Figure 45. Conversion of paddy fields in central built-up area 2015 – 2020

Source: (Top: Google earth Pro 7.3.4.8573 (1/4/2015). Sam Neua, Laos. Coordinates 20°24'40.59"N, 104° 2'59.35"E, Eye alt 1.12 km) (Bottom: Google earth Pro 7.3.4.8573 (2/14/2020). Sam Neua, Laos. Coordinates 20°24'40.59"N, 104° 2'59.35"E, Eye alt 1.12 km)

Figure 46. Conversion of paddy fields in urban extension area 2013 – 2019

Source: (Top: Google earth Pro 7.3.4.8573 (3/1/2013). Sam Neua, Laos. Coordinates 20°25'53.57"N 104° 2'0.27"E Eye alt 1.59 km) (Bottom: Google earth Pro 7.3.4.8573 (2/14/2020). Sam Neua, Laos. Coordinates 20°25'53.57"N 104° 2'0.27"E, Eye alt 1.59 km)

Urban Area Types

Built-up/ Constructed Areas

The approximate sealed surface area in 2011 was 280 ha, which had almost doubled to approximately 491 ha by 2021 and is mostly located in the formally dedicated building area, comprised of paved roads (concrete or asphalt), footpaths and the central business area. It is common practice throughout the town for properties of all types to cover their respective surface area with concrete, leaving little or no unsealed area for infiltration. This may also create an urban heat island effect, which can raise temperatures within the town (Figure 47 and Figure 48). Runoff is diverted to the stormwater drainage network significantly contributing to flood risks, while infiltration on-site is very limited, and an area's natural drainage corridors are not necessarily factored into the drainage design. Currently there are no building regulations for any given urban zone that controls the ratio of sealed surface and infiltration area on a plot.

Figure 47. Sam Neua's Town constructed area in 2011.

Source: (generated with QGIS, based on satellite image from Google Earth Pro 7.3.4.8642, 14.02.2020, Sam Neua, Laos, 20°25'1.50"N / 104° 2'52.33"E Eye alt 8.01 km, TUB 2022)

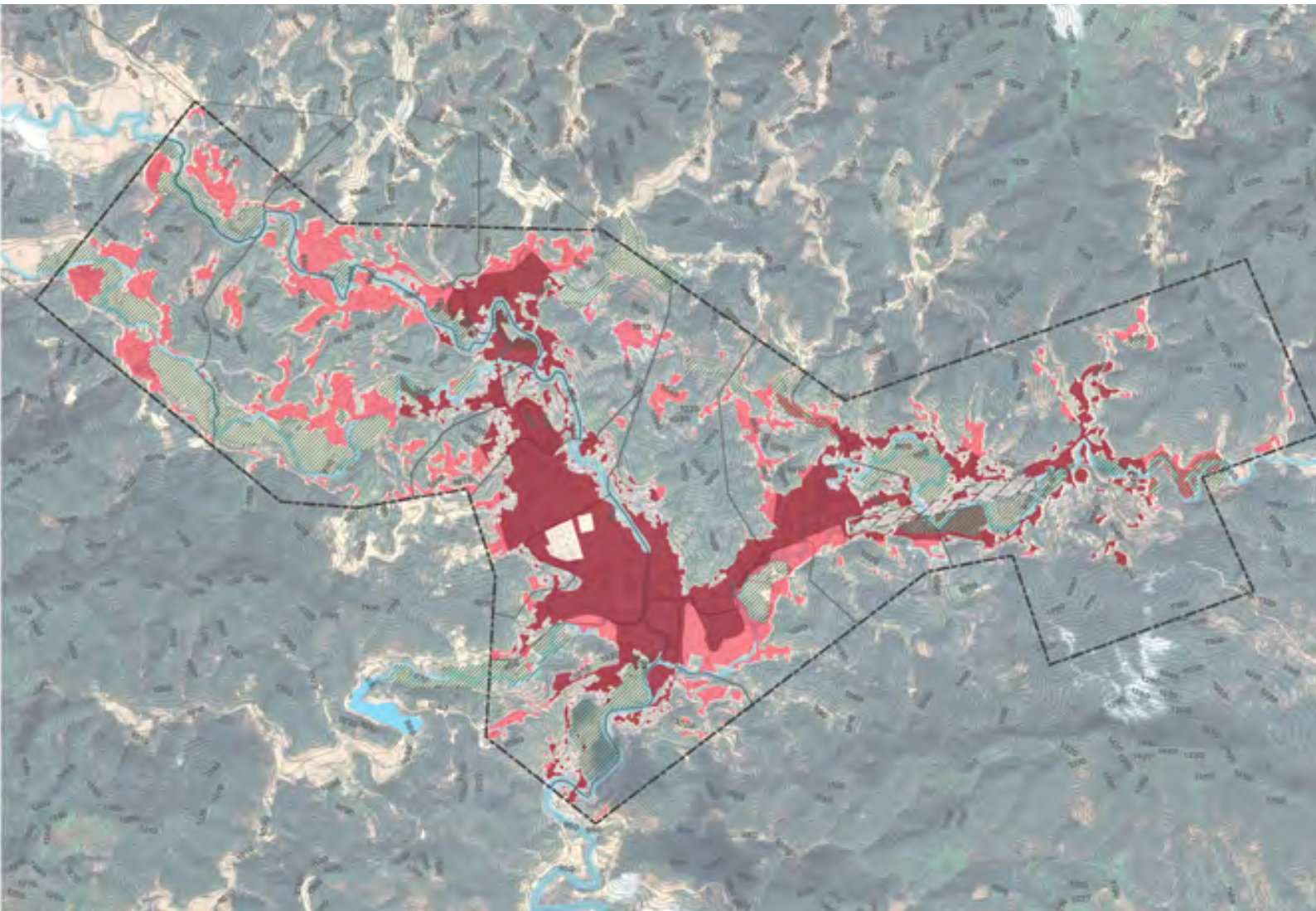


Figure 48. Examples of concrete used too seal various property types in Sam Neua

Source: (TUB, 2022)

According to urban planning regulations for the urban area in Sam Neua, buildings **can cover up to 60% of the total land area (plot)** and for **extension areas, buildings can cover up to 50% of the total land area**. Non-surfaced area is comprised mainly of forest and agricultural space outside of the built-up/constructed area (Figure 49). Buildings in the central old town (central area) appear to exceed these regulations, as shown below by the satellite photo (below) of the **urban form displaying very tightly packed residential blocks**; this does not appear to be the case for most new developments in the extension areas, which have larger plot sizes and much lower density.

Figure 49. Buildings typically occupy most of their individual plot areas and are tightly positioned next to neighbouring buildings

Source: (Bottom: Google earth Pro 7.3.4.8573 (2/14/2020). Sam Neua, Laos. Coordinates 20°24'47.52"N 104° 2'53.05"E alt 774m)

Urban Agricultural Land, Forest and Water Bodies

The town enjoys a considerable amount of agricultural area, various types of forest area, and public parks with a combined area of 782 ha, which equates to **55.2% of the urban planning area.** Wet rice paddy field area comprises 143 ha, or 10.1 %, of the urban planning area. Blue space consists of surface waters (rivers and streams) and aquaculture (fish ponds) with the following approximate amounts (Figure 50):

- River and streams = 37,04 km;
- Lake and reservoirs = 6.1 ha;
- Fish ponds = 9,97 ha

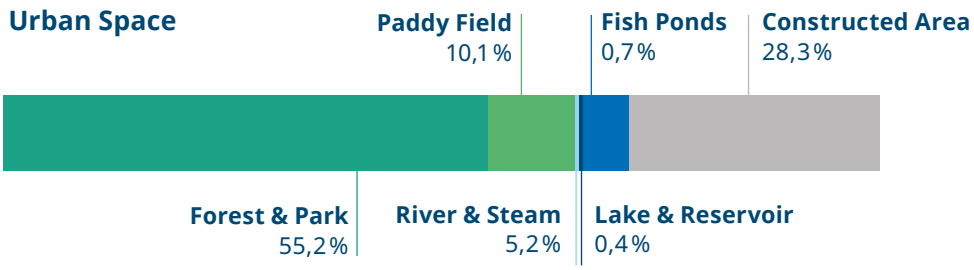


Figure 50. Breakdown of main urban area types within the urban planning boundary
Source: (TUB, 2022)

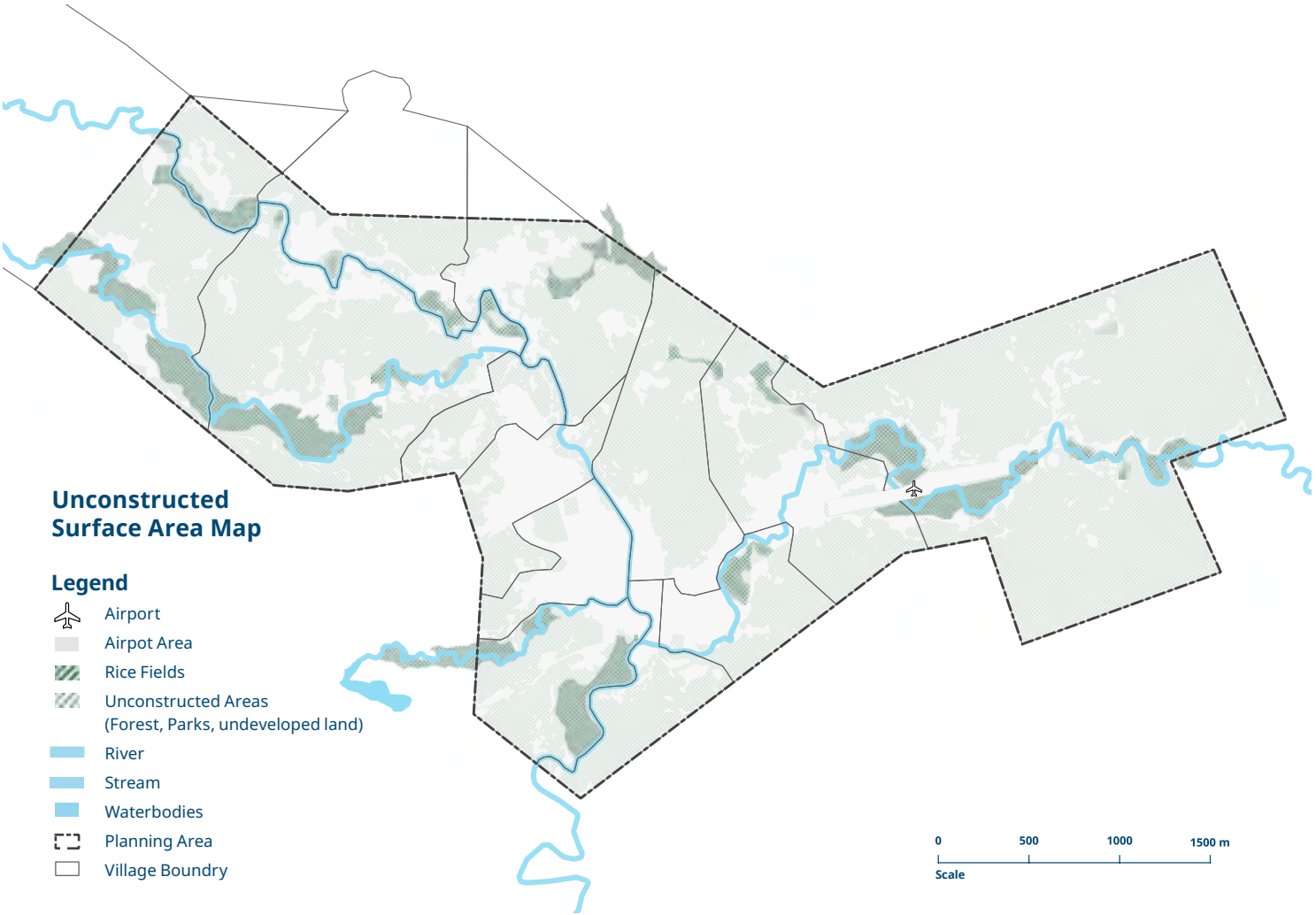
Figure 51. Sam Neua Town and one of the main bridges in the city center
Source: (PolyUrbanWaters 2022)

Figure 52. Fish Ponds in Sam Neua's Urban Extension Area as well as building area

Source: (Top: Google earth Pro 7.3.4.8573 (2/14/2020). Sam Neua, Laos. Coordinates 20°25'3.59"N 104° 2'1.87"E alt 779 m) Bottom: Google earth Pro 7.3.4.8573 (2/14/2020). Sam Neua, Laos. Coordinates 20°25'48.68"N 104° 2'29.08"E alt 639 m)

Figure 53. Sam Neua's forest and agricultural area.

Source: (generated with QGIS, based on satellite image from Google Earth Pro 7.3.4.8642, 14.02.2020, Sam Neua, Laos, 20°25'1.50"N / 104° 2'52.33"E Eye alt 8.01 km, TU Berlin, 2022)



Public Spaces

The larger new town park, soccer stadium and town square are important public spaces in Sam Neua as well as the numerous religious sites and public monuments. The building of new public spaces appears to be given special significance in the development progress of Sam Neua as gifts from ”friendship countries”, such as Vietnam. Spaces such as the new Town Park and central square (below) have been designed with special regard according to the green vision of the town and are maintained. In this sense, the green vision for the town entails a high use of larger, appropriate tree species in and around public spaces, which should be combined with other urban greening options (green infrastructure) throughout the entire town (Figure 54 and Figure 55).

Figure 54. Town Park and main town square – key public spaces in Sam Neua

Source: (TUB, 2022)

Figure 55. Tree planting in and around public spaces and along some roads is a chosen method for achieving the town's green vision; which could be combined with other urban greening options in the future throughout the town

Source: (TUB, 2022)

Settlements and Main Building Types

The following types of settlements and characteristics are identified in the town:

(1) Settlements in the built-up area: Usually located along the main, paved roads in the town, as well as the center of the urban area. Characterized by a mix of old and recently expanded buildings ranging in height from one to two stories. Various settlements along the main roads have multifunctional uses, offering services from the ground floor ranging up to three stories. Typical construction materials for this typology are brick and wood and in the recently added buildings concrete structures are used (Figure 56).

Other significant building types include large multi-story administration office buildings, new large- scale hospital, hotels and guest houses, and central market halls as photos in Part A have already shown.

(2) Settlements in the built-up area with high density: Located in the first settled parts of the urban area in the town and characterized by the highest density where the ongoing extension and improvement of the original typologies can be observed. The buildings are constructed from a mix of materials, such as wood, wooden shingles, zinc panels and brick. The original typologies usually have only one floor although further vertical extensions are visible but do not exceed one additional floor and can be recognized by construction material upgrades (Figure 57).

(3) Settlements in the peri-urban area: Located in both flat and hilly areas of the town with less density. Consisting mainly of single-family housing, ranging in height from one to two stories. Construction materials are mainly brick, concrete and wood.

Figure 56. Typical housing settlements located in the built-up area with high density of Sam Neua Town

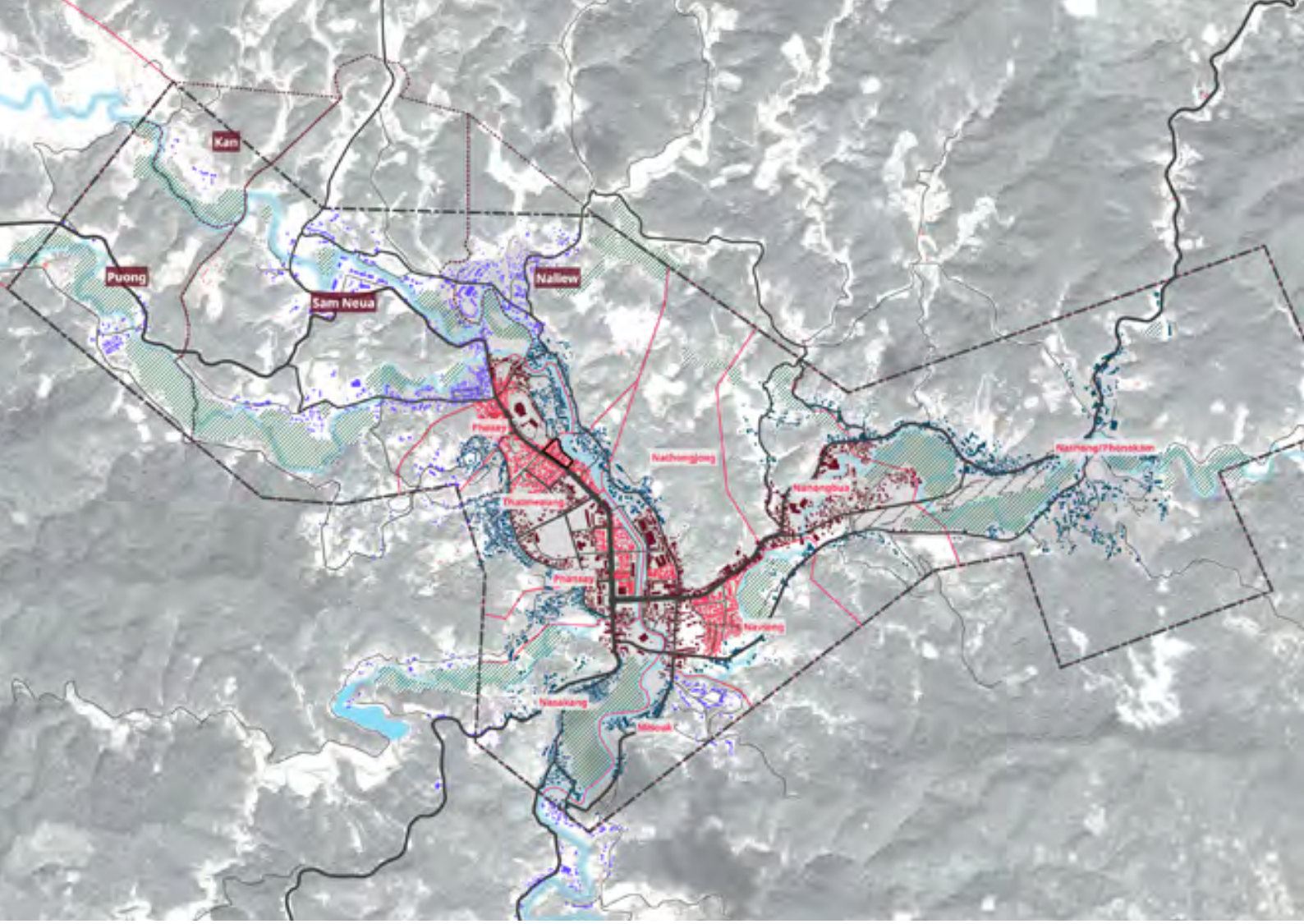
Source: (TUB, 2022)

(4) Settlements in the agricultural area: Can be found mostly in the remotely located areas on the hills and paddy fields. Small, single-story houses and storage characterized by simple wooden constructions. It can be observed that slowly the wooden structures are being replaced by concrete housing.

(5) Settlements in the urban extension area: Construction materials are mainly locally produced or sourced brick and wood although a change of materials can be observed in the newest and more expensive constructions, or constructions of government buildings with local brick and wood being replaced by concrete structures. These new plots are significantly larger than in the built-up area and as former rice paddy, they are filled and leveled with a large amount of soil before construction starts.

The are no informal settlements identified although many housing constructions are not formally documented or mapped.

Figure 57. Examples of identified types of housing settlements.
Source: (PUW, 2019)



Settlement Typologies Map

0 500 1000 1500 m

Scale

Figure 58. Map of identified various types of settlements.

Source: (generated with QGIS, based on satellite image from Google Earth Pro 7.3.4.8642, 14.02.2020, Sam Neua, Laos, 20°25'1.50"N / 104° 2'52.33"E Eye alt 8.01 km TUB, 2022)

Legend

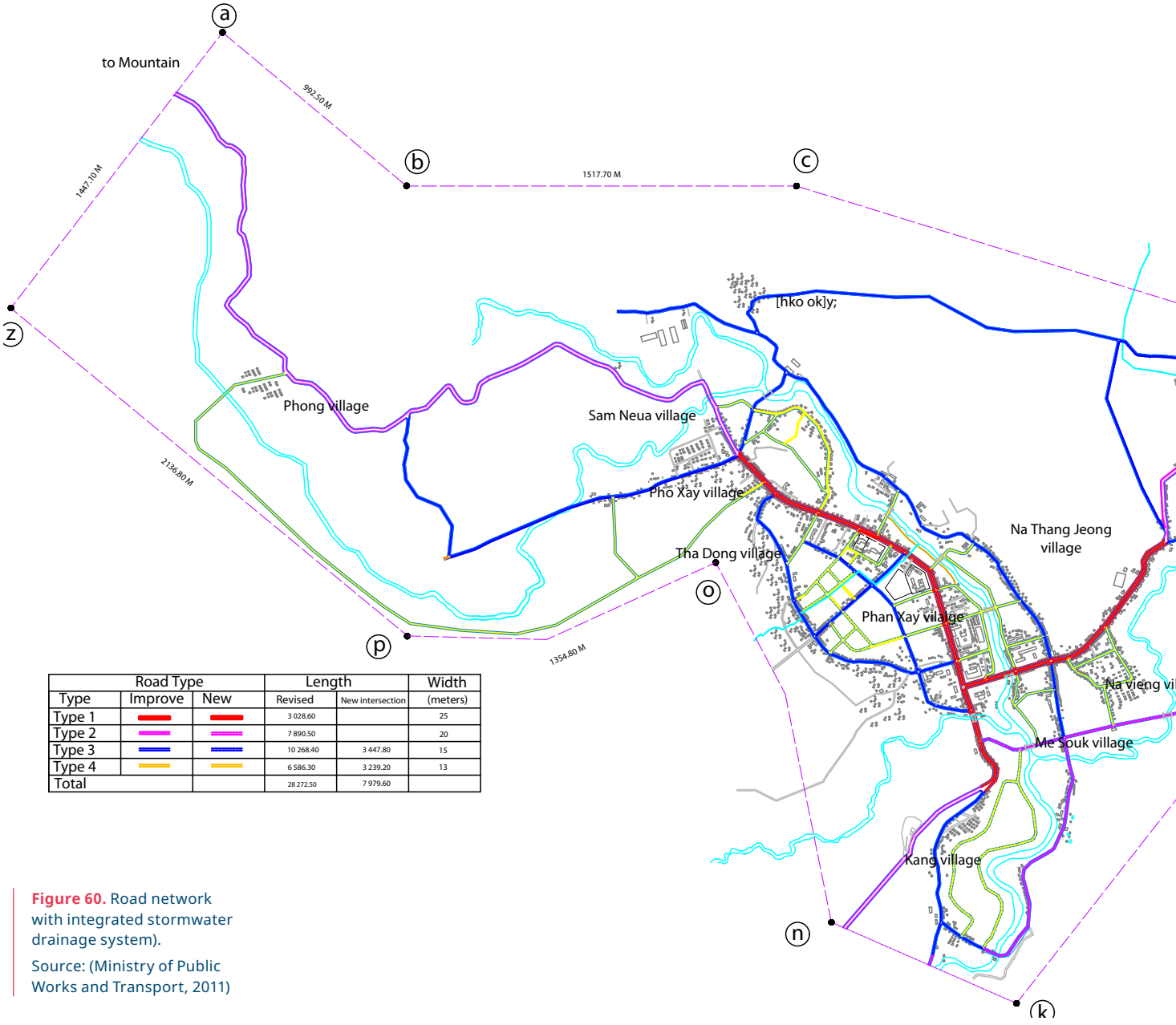
- Airport_point
- Airport
- Rice Fields
- Settlement in the built-up with a high density
- Settlement in the built-up area
- Settlement in the urban extension area
- Settlement in the peri-urban area
- Settlement in the agriculture area
- Sample Block
- Road Type 1
- Road Type 2
- Road Type 3
- Road Type 4
- Other
- Planning Area
- Village Boundary
- Village Boundary (updated-07.22)
- River
- Stream
- Waterbodies
- Building Area Lill 2011

Figure 59. Locally produced construction materials, such as brick and wood

Source: (PUW, 2019)

Road Network Infrastructure

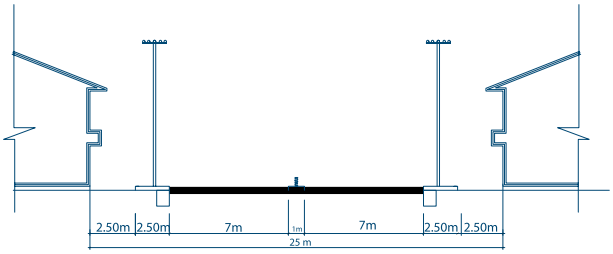
Key internal areas of the town are highly accessible by motorcars, motorcycles, buses, trucks, bicycles, and pedestrians due to an extensive network of surfaced roads, mostly with integrated piped or culvert drainage and footpaths. Categories vary between one to four (See Figure 60) with an approximate total of 46 km. Generally, roads are maintained and kept in good condition. Unsurfaced road networks also exist, yet to a lesser extent in various locations throughout the town and only partially in new extension areas. Some unpaved roads are planned to be paved and fitted with stormwater drainage systems. Various locations exist where roads are more vulnerable to flooding, particularly where blockages occur in the stormwater drainage system.



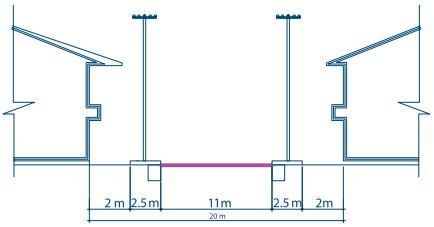
Road Type			Length		Width
Type	Improve	New	Revised	New intersection	(meters)
Type 1			3 028.60		25
Type 2			7 890.50		20
Type 3			10 268.40	3 447.80	15
Type 4			6 586.30	3 239.20	13
Total			28 272.50	7 979.60	

Figure 60. Road network with integrated stormwater drainage system).

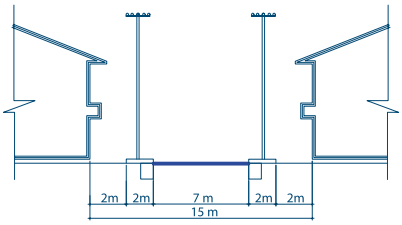
Source: (Ministry of Public Works and Transport, 2011)



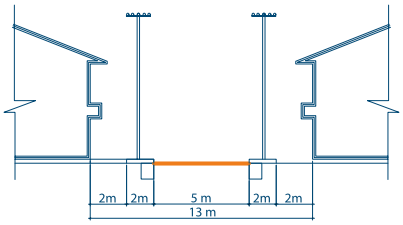
Road type 1



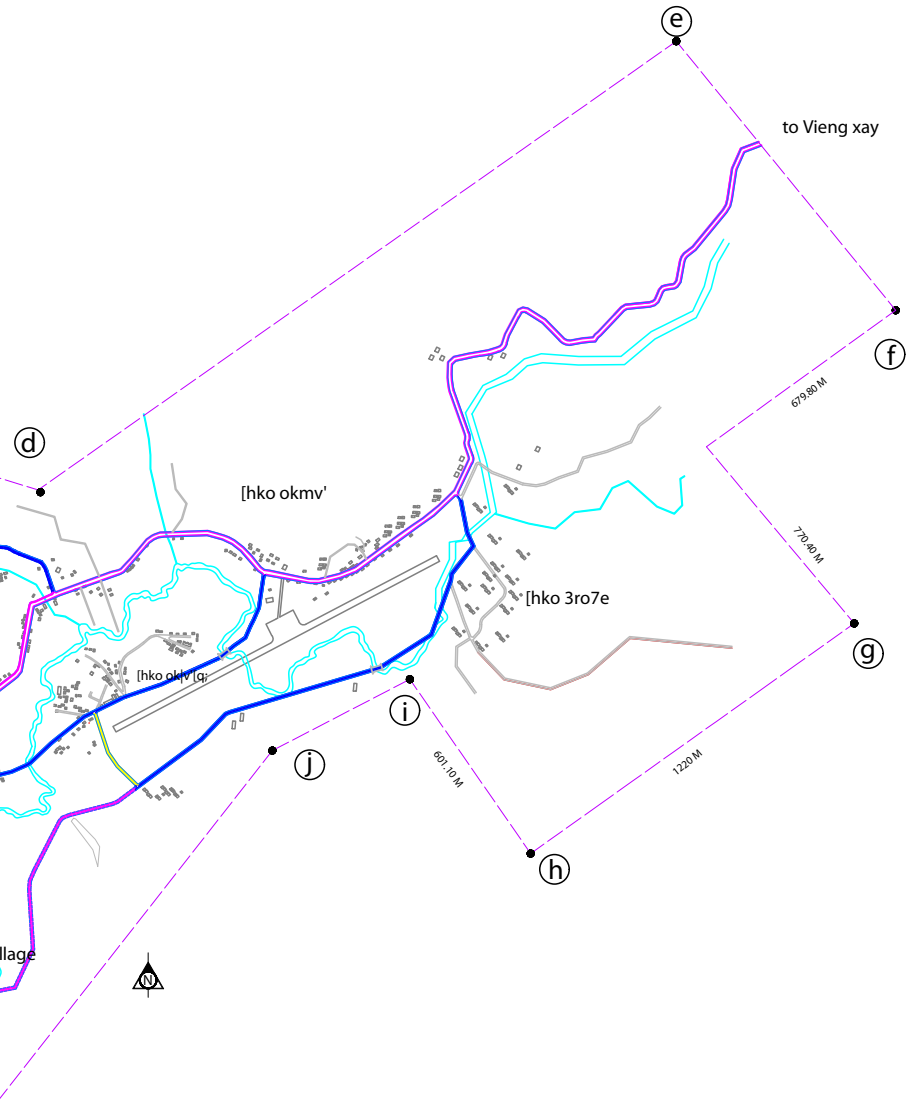
Road type 2



Road type 3

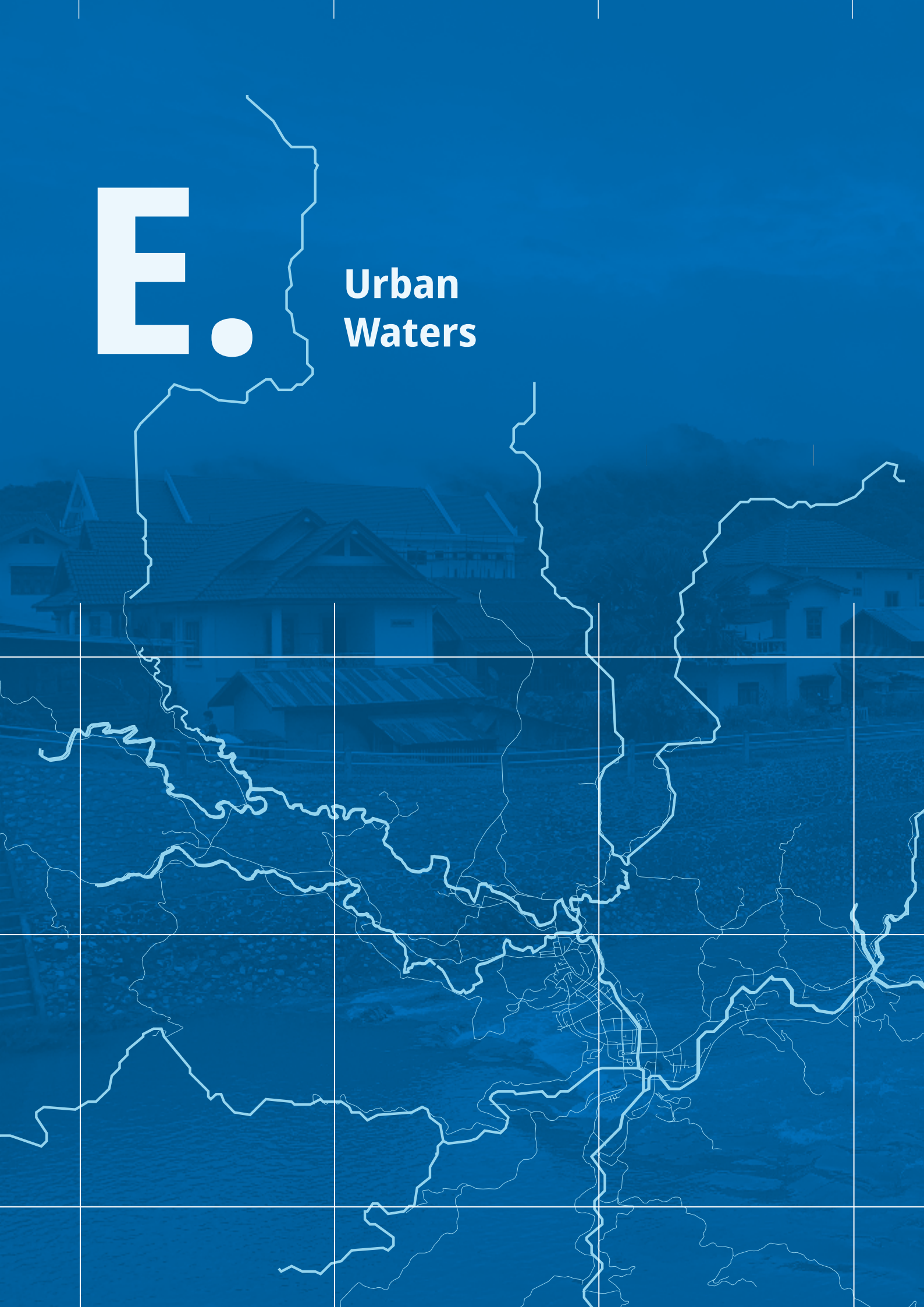


Road type 4



Legend:

- Existing road
- Concrete walking
- Building
- Steam/river


Urban
Waters

Key Messages of Section

Although richly endowed with water resources, Sam Neu's **urban waters are coming under increasing pressure** from the changes in landuse in the overall water catchment area, the urbanisation process and climate change.

Deforestation and **loss of water** buffers, such as the paddy fields and riperian vegetation together with dynamic **sealing of lands**, contributes to an increased stormwater runoff regime and thus increased vulnerability to flooding events.

With the **degradation of ecosystems and blue-green infrastructure** and the discharge of untreated wastewater, the quantity and quality of surface waters are suffering, which ultimately translates into the deterioration of groundwater quality.

Overall, Sam Neua needs **water-related infrastructure development and management of urban waters** that can accommodate the emergence of a modern, increasingly complex town and its needs.

In addition to the changing water demands and water use patterns associated with this urban development, any infrastructure development must take into account the intensifying **heavy rainfall events** and **prolonged droughts** caused by **climate change**.

In addition to securing the water supply, **adequate wastewater and stormwater management** strategies are needed that are adapted to the town's financial and institutional capacities.

Especially in stormwater management, the planning and implementation of **hybrid infrastructures**, i.e., the combination of grey and green solutions, is possible. Green /nature-based solutions should reduce the pressure on grey drainage infrastructures and ultimately on wastewater systems through their infiltration capacity. However, for comprehensive protection against uncontrolled water run-off, the construction of water retention basins will be essential.

So far, there is hardly any **capacity and data on water quality monitoring**. However, such monitoring capacities are indispensable for effective urban water management. Therefore, a comprehensive management, monitoring and evaluation mechanism is required.

Sustainable management of water resources requires effective approaches at the water catchment level. In this context, respective authorities should promote **an Integrated River Basin Management approach** supplemented by a 5-year Nam Xam River Basin Management Action Plan.

The State of Urban Water Resources

Surface Water Resources: Streams, Reservoirs, Lakes, and Ponds

Any sustainable development of Sam Neua town is linked to the sustainable management of its surface water system.

The Nam Xam River throughout its course is found to have a strong underground flow. Since the Nam Xam River valley collects the waters of altitudes above 2000m from the Houa Mountain (ADB, 2019), it also explains the fact that it has the largest inflow during the wet season (June to August) when the river overflows causing flooding of the areas along the river and eroding them, mainly in the southern part of the town.

Within the urban area, a number of different streams discharge their water to the Nam Xam water body. In addition to rivers, Sam Neua also has a number of lakes and reservoirs, such as the Houay Hin Men Reservoir and the Houay Hin Dem Reservoir, which have an important use as the water source and back up water source for some of the bottled water factories.

The importance of sustainable management of surface waters is evident in their overwhelming importance to the water supply of the town, its communities and the economy. Unlike many other towns in Laos and in the SEA region, Sam Neua Town's water users – be they water operator, bottled water factories, public institutions, private households, businesses and agricultural commercial/substiance units – do not yet rely on shallow wells and deep wells but exclusively on streams and flowing springs.

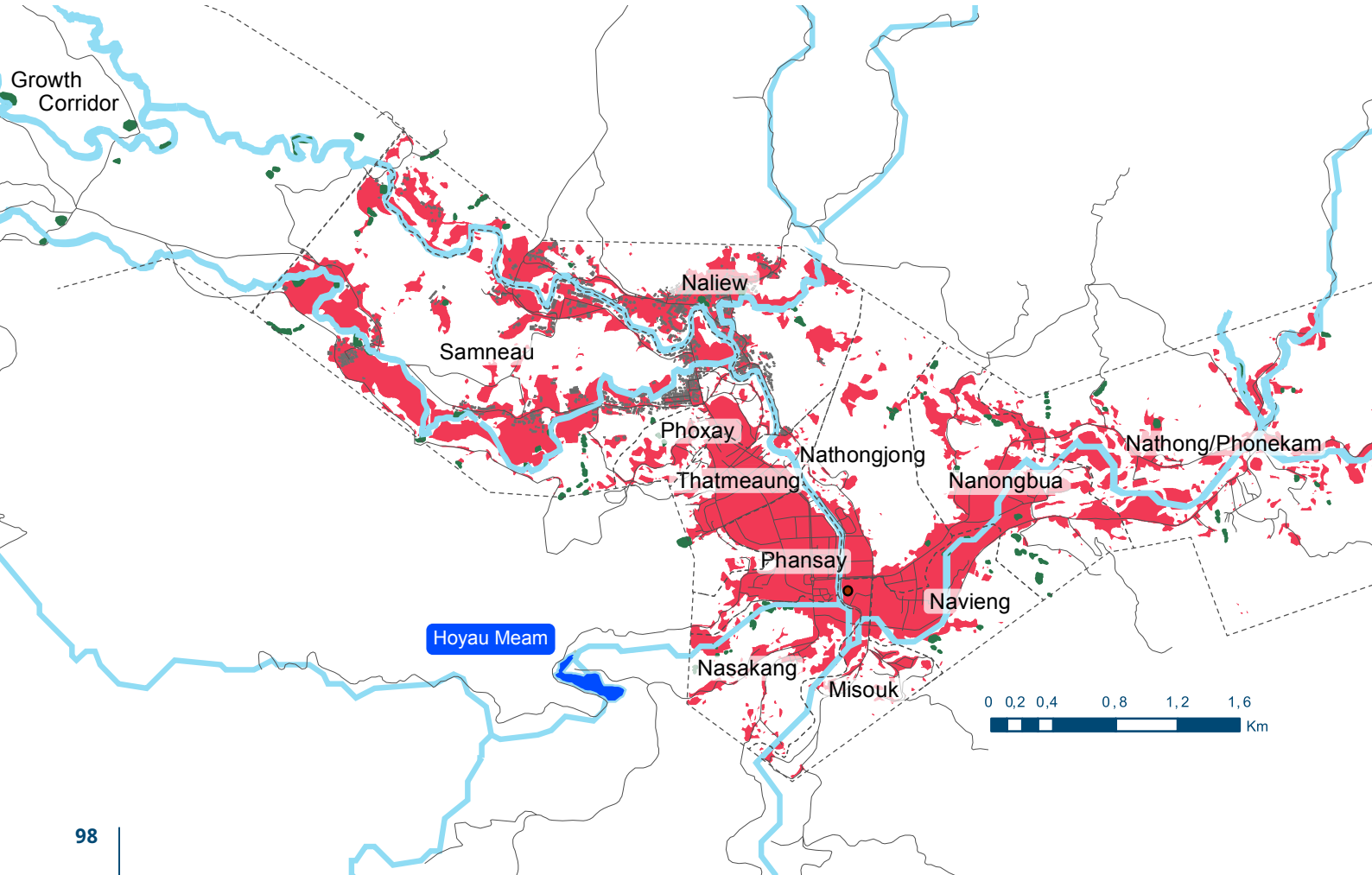


Figure 61. Nam Xam River network, reservoirs and fishponds; Sam Neua town, Lao People's Democratic Republic. 20° 25' 49"N, 104° 01' 47"E, Eye alt 5726 m.CNES/AirBus

Source: (http://www.earth.google.com [November 10, 2021] (February 14, 2020). Design: ITT, 2021)

Figure 62. Meandering of Nam Xam River and lack of riparian buffer.

Source: (Sam Neua, Lao People's Democratic Republic. 20° 25' 32.35 "N, 104° 01' 18.16"E, Eye alt 4.07 km.; CNES/AirBus. http://www.earth.google.com [November 10, 2021]. (February 14, 2020). (Bottom photos: PUW team field trip, 2021)

The numerous fishponds in Sam Neua are in most cases located along the Nam Xam River and also in agricultural and hilly areas where the change in elevation provides the perfect conditions to build the ponds. Fishponds are one of the most important living aquatic resources for nutrition and income in Sam Neua (BORDA, 2022d).

Furthermore, the preservation, maintenance and sustainable use of rivers, streams, lakes and ponds and the development of nature-based-solutions by local governance can bring great benefits to the town in terms of tourism. The Sam Neua network, reservoirs and fishponds are shown in Figure 61. Nam Xam River network, reservoirs and fishponds; Sam Neua town, Lao People's Democratic Republic. 20° 25' 49"N, 104° 01' 47"E, Eye alt 5726 m.CNES/AirBus.

Today, Sam Neua's river system suffers the long-term consequences of poor management, in particular changes in the hydro-morphology of the rivers, loss of biodiversity, and pollution (see more details in the annex).

For example, human interference has:

- accelerated many natural geological processes in the river, such as river bed and bank erosion, causing significant deterioration.
- contributed to a significant loss of a riparian buffer area.
- caused water pollution by uncontrolled wastewater discharge and environmental pollution and improper solid waste disposal.

In the future, advanced instruments, such as a Basin Management Strategy and a River Basin Management Action Plan should contribute to the sustainable protection of these waters. In the meantime, in the course of progressive implementation, targeted measures for integrated water protection should be undertaken, as outlined below.

Legend

- Sam Neua city centre
- Sam Neua river network
- Road Network
- Village Border
- Lake and reservoirs
- Fish ponds
- Buildings
- Sealed surfaces

As a result of deficiencies in river management or misuse of the vegetated buffer-strip near the river, the riparian zone of the Nam Xam River has suffered significant damage (there are frequent and extensive meanders, lack of necessary vegetation belts – from low to high plants – or vegetation buffer-strips do not exist at all). As the river traverses cultivated agricultural land, in some cases the riparian zone has been cultivated as agricultural land. This has affected the ability to protect the land from river flows, which can cause floods. Riparian areas also prevent the transfer of pollution between agricultural lands and residential areas towards the river on the one hand and surface waters and the aquifer on the other. Riparian buffers are preserved to ensure (A. DeBarry, 2004):

- the interruption of the movement of non-point source pollutants carried by surface water runoff,
- the removal of nitrogen, phosphorus and other substances that can pollute water bodies,
- the stabilization of stream banks and the minimizatin of erosion,
- the decrease in the frequency and intensity of flooding, so preventing sedimentation of waterways through shading,
- the reduction in fluctuations in stream temperatures and prevention of elevated temperatures harmful to aquatic life,

the provision of a secure movement for wildlife within natural corridors, and the replenishment of groundwater.

Surface Water Pollution Challenges for Sam Neua Town

Lack of Riparian Buffer Area

As a result of deficiencies in river management or misuse of the vegetated buffer-strip near the river, the riparian zone of the Nam Xam River has suffered significant damage (there are frequent and extensive meanders, lack of necessary vegetation belts – from low to high plants – or vegetation buffer-strips do not exist at all). As the river traverses cultivated agricultural land, in some cases the riparian zone has been cultivated as agricultural land. This has affected the ability to protect the land from river flows, which can cause floods. Riparian areas also prevent the transfer of pollution between agricultural lands and residential areas towards the river on the one hand and surface waters and the aquifer on the other. Riparian buffers are preserved to ensure (A. DeBarry, 2004):

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- the reduction in fluctuations in stream temperatures and prevention of elevated temperatures harmful to aquatic life,
- the provision of a secure movement for wildlife within natural corridors, and the replenishment of groundwater.

Improper Waste Disposal and Urban Water Resources

An open unmanaged dumpsite is still a common practice in the Lao People's Democratic Republic, and Sam Neua is no exception where waste disposal involves the deposition of waste into an open space near Na Ang village or dumped illegally along roadsides. The collection and disposal of waste is undertaken without regulation, control or operational and engineered management measures, including leachate and gas management. The waste disposal site at Na Ang village is poorly built with minimum or no site preparation prior to waste disposal. Its capacity is unknown, and there are no records of the quantities and types of waste that have been disposed.

The local terrain makes possible the penetration of leachate contaminants from dumped waste into the waters of the Nam Xam River and then it is dispersed and diluted in the groundwater. Currently, groundwater is not used to supply water to the population of Sam Neua, but it remains a potential resource for the future.

In general, surface water, groundwater and soil contamination are some of the hazards linked with open dumpsites due to the lack of leachate collection and treatment, shortages of cover and a lack of engineered designs for the waste disposal locations (Ferronato & Torretta, 2019; Yadav et al., 2019).

Leachate contains concentrations of heavy metals, such as iron, manganese, cadmium, chromium, copper, lead, nickel, zinc, and mercury. The concentration of heavy metals varies significantly based on the waste composition of the dumpsite (Abiriga et al., 2020). Also, leachate constitutes soluble and insoluble organic and inorganic products as a result of different physical, chemical processes occurring inside the waste pile.

The waste disposal site poses major problems related to the pollution of the waters of the Nam Xam River and also endangers the health of residents. Research from previous studies indicates that the closer people are to landfill sites, the more they will be affected by health problems related to asthma, diarrhea, stomach pain, reoccurring flu, cholera, malaria, cough, skin irritation, and tuberculosis (Njoku et al., 2019) concerning environmental issues, health problems, and life satisfaction. Results from the study showed that 78 % of participants living closer to the landfill site indicated serious contamination of air quality evident from bad odours linked to the landfill site. Illnesses such as flu, eye irritation and weakness of the body were frequently reported by participants living closer to the landfill than those living far from the landfill.

Surface Water Quality

The collection and analysis of water quality data was in the past the responsibility of the Department of Irrigation (DOI) and currently includes 13 parameters (Pathoummady, 2010). According to measurements reported by ADB (2018), the current local water treatment plant provides insufficient treatment in respect to the Laotian drinking water standards, but there are plans to improve this treatment through the renewal of the water supply system. For the planned upgrade of Sam Neua's water supply system, water tests were conducted at the Nam Xam, Houay Man and Xim Rivers (ADB, 2018). Twenty-four parameters were evaluated for the Nam Xam River only, while the other rivers were only tested for six to nine parameters. The report further incorporates limited information from the DOI and provides a single impression of the water quality condition as of 2017.

Today, the Department of Natural resources and Environment (DoNRE) is responsible for the monitoring of the water quality in the Nam Xam River, with measuring points upstream (near Houa Xiang village), in the town (below the market), and downstream of the town (ca. 1 km outside the planning area). Monitoring takes place every three months and regularly includes the standard parameters of water temperature, pH, electric conductivity, dissolved oxygen, total suspended solids and total dissolved solids, salts, heavy metals, Alkalinity, COD, BOD, Ammonium, Nitrite, Nitrate, Phosphorus and E-coli although these are collected in varying intervals. There are existing small-scale capacities to conduct basic water quality testing, but more complex analysis requires laboratories in Vientiane or Thailand. Provided data, however, are currently only available for the years 2014–2015 (DoNRE, 2022). Initial tests by the project team showed presence of E-coli bacteria in all the smaller tributaries of the Nam Xam River and indications of algae bloom in standing water bodies.

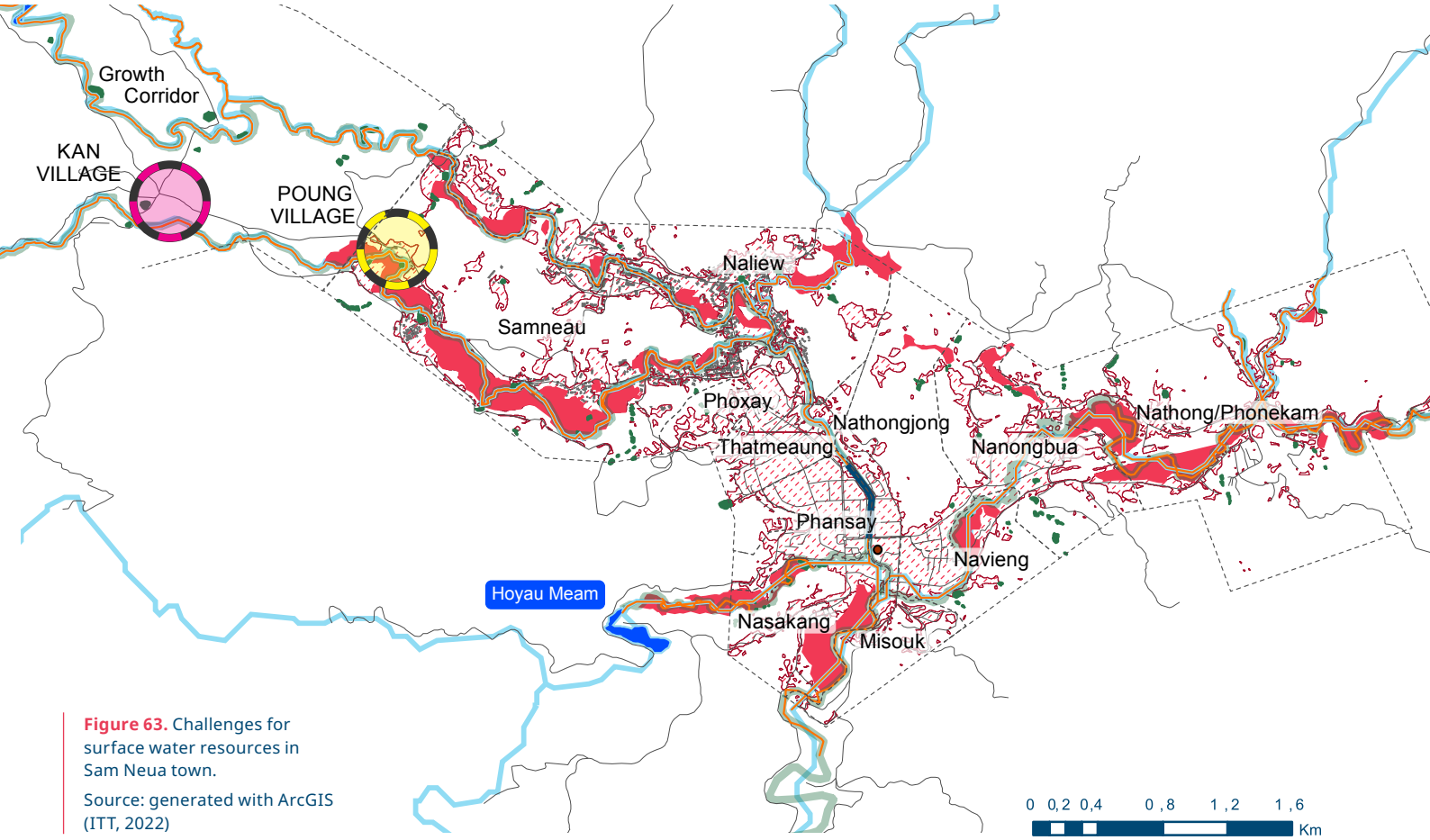


Figure 63. Challenges for surface water resources in Sam Neua town.

Source: generated with ArcGIS (ITT, 2022)

Therefore, the scarcity of available water quality measurements means no quantifiable information on pollutants of water in Sam Neua are available to date. Local information identifies the main sources of pollution as domestic wastewater, open defecation on the riversides, as well as pollution from construction sites and the local market managed by drainage channels without any water quality control. Along the main river, evidence of eutrophication has been noted and during intense rainfall, stormwater drains overflow flooding the town for hours due to limited capacity and clogging. Local reports indicate that there is air pollution through dust from unsealed roads, and discharged oil residue from textile dyeing and motor vehicle repair and maintenance (See Wastewater Management section for further details).

Spatial distribution of the challenges of surface water resources in Sam Neua is shown in Figure 63. Challenges for surface water resources in Sam Neua town.

Key Water-Related Disaster Risks

According to the LAO PDR Disaster Management Reference Handbook, the disasters and natural hazards that most commonly affect Laos include flooding, drought, storms, earthquakes, and landslides (CFE-DM, 2021). For Sam Neua, the primary water-related risks to urban development are deforestation, flooding, and landslides.

Floods

Natural hazards and changing land use patterns pose a high risk to Sam Neua. Water-related risks include flooding caused by more extreme rainfall during the wet season, but also drought during the dry season that can lead to water shortages. Flood vulnerability may increase in the wake of climate change and the associated higher frequency and intensity of heavy rainfall events

Floods in 2018 were particularly significant in terms of immediate damage and casualties. These floods also resulted in the up-dating of the disaster management policies for the country. In July 2018, Laos was struck by Tropical Storm Son-Tinh, which caused heavy rains and flash floods (CFE-DM, 2021). During this event, urban areas throughout Sam Neua town were significantly affected by flooding, which included considerable damage and repair costs to private buildings and infrastructure in various central urban locations, as well as rice paddy fields further upstream in the urban extension area and downstream.

During the rainy season, storms increase the water level of the Nam Xam River (see Figure 63), which cause it to overflow in areas along the river, and blocked drainage due to solid waste build-up exacerbating flooding during heavy rain, flooding the town for hours to levels of 10 to 20 cm. There is a 10-year incidence of flooding along the Nam Xam River mainly in the area from Phan Xai to Me Souk villages lasting one to two days and also caused by heavy rain and the heightened water level of the Nam Xam River.

Legend
Silk Coloring focus Village

- Kan Village
- Poung village
- Sam Neua City Centre
- Artificial Riverbed
- Extensive meandring or River
- Sam Neua River Network
- Road Network
- Village Border
- Lake and Reservoirs
- Fish Ponds
- Waterways lines Buffer
- Buildings
- Sealed Surfaces
- Rice Fields

Water in the Town – Story 3

New Upstream Flooding and Destruction of Rice Paddy Fields on the Nam Xam River

Since 2017, during the rainy season a farming family cated in Phoung village, upstream of the town centre on the Nam Xam River, have been faced with annual flooding of their expansive rice paddy fields. Before 2017, they reported that there was no such problem. However now, they suffer significant damage to their fields and crops, which is very costly to repair. For example, in 2019, 50% of their fields were damaged at a cost of 4.5 million LAK to repair. Other years, repair costs are 2 million LAK on average. Many family houses have also suffered damage during flooding. During discussion it was established that these experiences are repeated by other famers in the area. The family see that since surrounding hills have been cleared for promotion of agriculture and animal husbandry, the problem of flooding is growing. Now, pollution of the river with sand and mud washed down from the surrounding hills occurs rapidly, even as soon as a small amount of rain has fallen. They realise that runoff speeds and volumes are increasing due to the loss of forest on the surrounding slopes. In an attempt to protect fields, prevent erosion and improve the health and security of the riverbank, they attempted to plant trees considered to be particularly suitable to withstand flooding with strong root systems, yet their attempts were in vain as the next flood waters simply washed them away. With such limited adaptive capacity, spending more money and time seems pointless in the face of this new annual natural challenge. (BORDA, 2022c).

Deforestation in Sam Neua Extension Area

Figure 64. Phoung Village with surrounding paddy fields, nearby construction and deforested areas

Source: (Google Earth Pro 7.3.4.8573 (2/14/2020). Sam Neua, Laos. Coordinates 20°25'34.54"N, 104° 01'17.45"E, Eye alt 798m))

Figure 65. 2018 flood in Sam Neua town

Source: (Ministry of Public Works and Transport, 2018)

Legend

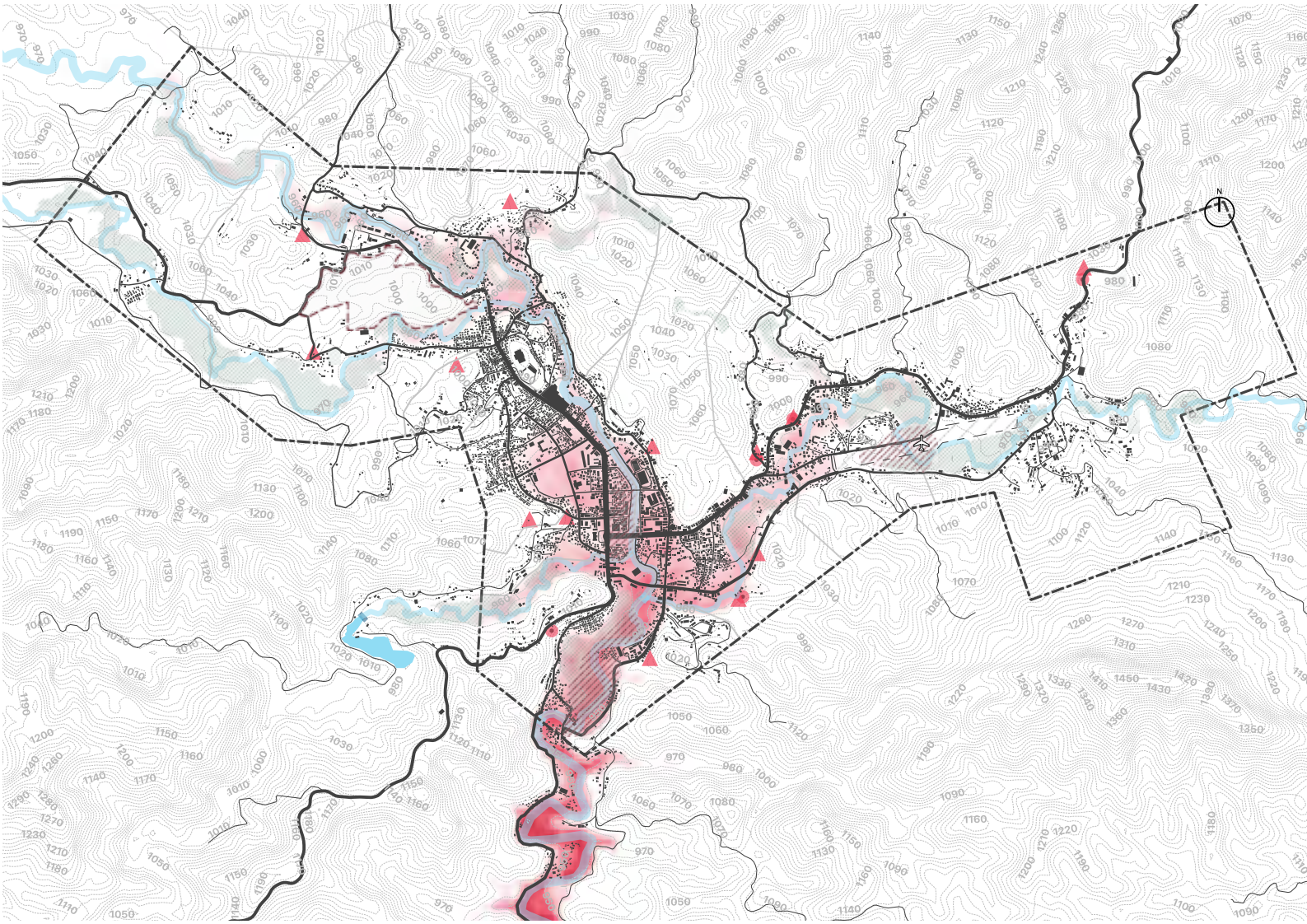
- Airport
- Airport Area
- Buildings
- Rice Fields
- Road Type 1
- Road Type 2
- Road Type 3
- Road Type 4
- Other
- River
- dam
- Stream
- waterbodies
- Planning Area
- Mudslides
- Land Sliede
- Flooding Zones (annotations from 07.22)
- Deforestation / New Agricultural Area
- Village Boundary
- Contour Lines – 10 meters

Low elevetion most suceptible to floods

- 934m
- 940m
- 947m
- 953
- 960
- 966m

Figure 66. Areas potentially vulnerable to flooding

Source: (Generated with QGIS, based on satellite image from Google Earth Pro 7.3.4.8642, 14.02.2020, Sam Neua, Laos, 20°25'1.50"N / 104° 2'52.33"E Eye alt 8.01 km, TUB 2022)



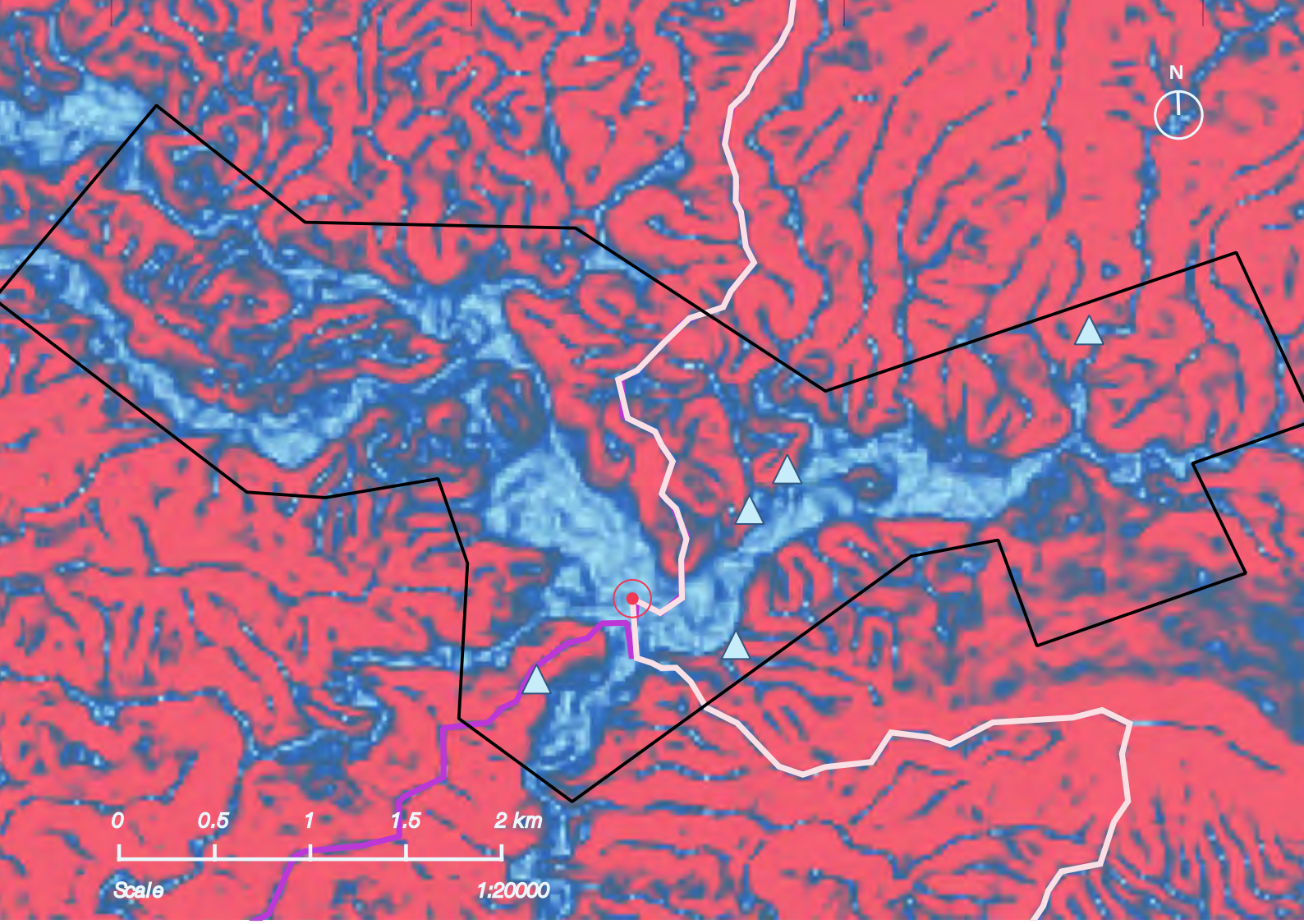


Figure 67. Slope angles around Sam Neua

Source: (Earthdata n.d, ITT 2022)

Figure 68. Landslide in Houaphan Province 2018

Source: (Hearn et al., 2020)

As mentioned in the example above, there is significant danger of flooding being amplified via a combination of current challenges: the large-scale (and increasing) conversion of rice paddy fields upstream and resultant loss of water retention and infiltration areas; deforestation in surrounding areas and the associated increase in run-off volumes and speeds combined with the large number of sealed surfaces throughout the town, particularly in areas demarcated in the figure above as vulneralbe areas. The speed at which deforestation and urbanization is taking place is apparent from the identified land cover changes between 2018 and 2020 in Chapter B.

In the urban area in 2015, attempts to mitigate the impacts of flooding have been made in the town, such as sealing river banks with stone masonry and widening the Nam Xam River. Yet, as evidenced by the size and damage to the central town area caused by the subsequent 2018 flood, this river-widening measure was insufficient to prevent flooding during more significant rainfall events. Further upstream, in the peri-urban extension areas, various home-grown attempts have been made by local residents, such as tree planting on riverbanks, the placing of boulders along river banks apparently to protect them from erosion, and bagging has also been used in some areas. However, it appears that these measures have had limited success. Currently, in the town centre, flood events are minimized by elevating the Nam Xam River's banks in some areas, such as near the new hospital, and placing sand bags at vulnerable locations in the town during periods of flooding (BORDA, 2021).

While it is apparent that the rice paddy fields act as flood buffers, it is **unlikely that farmers will choose to lend their land to this purpose if they do not receive compensation for damages and loss of livelihood** or if they can sell their land for other purposes.

Landslides

Deforestation in the hills around Sam Neua has the potential to increase the risk of landslides, a hazard which has already occurred in the past (Voßeler, 2019) (Figure 67).Figure 67. Slope angles around Sam Neua indicate that due to the topography of Sam Neua, it is surrounded by a lot of steep slopes that are susceptible to landslips. The likelihood of an increased risk is particularly great considering continued deforestation, which is often driven by population growth, infrastructure development, demands for natural resources and the conversion of land, exactly as predicted for Sam Neua and the region (WCS, 2015). According to local information, landslides occur along Road No.6 near Na Vieng, Na Sakang, Phoung and Na Ang and Na Nong Bua villages (Figure 68). In 2013 and 2019, these caused the deaths of four people and the destruction of houses, cars, and roads. As Sam Neua is mainly accessible via major road arteries, landslides affecting such roads increase the town’s vulnerability to road closures. Landslides and erosion are also a major cause of blocked drainage, as sediment and debris fill drainage networks throughout the town. As there is only limited cleaning performed by the UDAA, such blockages have become a major issue. Construction permit applications for fillings, excavations and riverbank protection are planned in cooperation between the DPWT and UDAA. Observed flood frequencies are stable, but the river flow has increased in strength (Interview with UDAA and DPWT- PUW, 2021).

Water Supply Management

Key Messages of Section

Sam Neua's local authorities have a plan to manage improvements to the water supply network and this aligns with the National Socio-Economic Development Plan (SDGs).

This includes the ADB expansion of the water supply coverage network to an **additional 800 connections (745 domestic, 15 institutional and 40 commercial connections) reaching 95 % of the population**, and the rehabilitation of the existing water supply system to **reduce the non-revenue water share from 36 % to 29%.**

A **significant proportion of the population (90%) are connected to the piped water supply system although nearly all of the population drink water from bottles**, not from the piped water supply system. This indicates a **lack of trust** in the quality of water from the piped system.

So far, **the tariffs** for the water supply system **allow operators to be financially sustainable**.

The systematic introduction and effective implementation of **water safety plans** and the **sustainable development of green infrastructures** can respond to an increased pressure on drinking water sources and can make a significant contribution to **water supply security.**

The significant **reduction of technical water losses** and the **dissemination of water harvesting structures** at private and public premises are essential strategic elements for reducing urban water consumption and thus for counteracting increasing water scarcity.

Projections indicate that **Sam Neua's water supply resources to 2045**, can be secured by improving the management of these water resources. However, projections on demand suggest **water shortages may continue**. The rate of **population expansion** will create difficulties to supply the future water demand while putting increased pressure on the town's natural water resources.

Climate change, urban development and population expansions threaten Sam Neua's ability to protect its water resources from **water contamination and water shortages**. By **enhancing Sam Neua's existing nature-based solutions** and **developing green infrastructure,** these risks can be reduced.

Conducting **appropriate monitoring and analysis of the water quality** is challenging given the lack of local capacity, such as local water quality analysis laboratories. **Local water quality laboratories** would increase the efficiency of the water quality monitoring and testing and reduce the logistical challenges with exporting water quality samples to neighboring countries.

The **complex system of water governance** can **hinder future development** of a modern and effective water sector in Sam Neua

The State of Urban Water Supply Sources

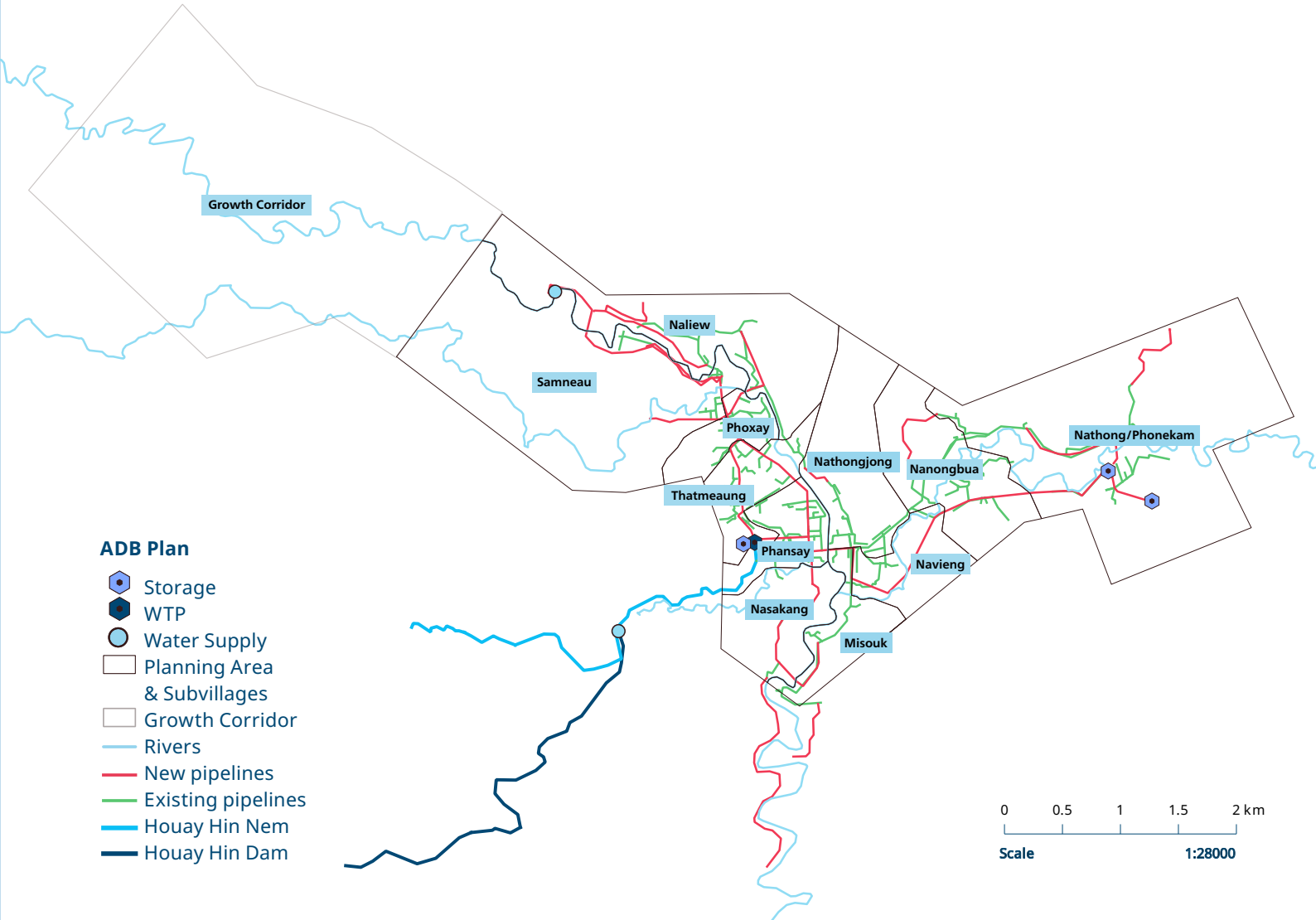
Water Supply Sources

The Asian Development Bank (ADB) supports the rehabilitation and upgrade of Sam Neua's water supply system. These proposed upgrades are outlined in this section and provide an image of the planned changes to urban water infrastructure in the town (Figure 69. Map illustrating the ADB plan.).

According to local authorities, the main water sources for Sam Neua town are the local rivers and reservoirs with water provided to citizens through a gravity flow system (McNamara, 2019). Reports from the ADB state that the Houay Hin Men and Houay Hin Dam, which are both small streams west of the town (see Figure 69. Map illustrating the ADB plan.), have been used for the town's water supply since approximately 1997 and 2007 respectively. Both streams are secure water sources, which can supply the town over a long period (ADB, 2018). They provide a combined total water supply of 2,500 m^3/day, which is first treated at a water treatment plant close to the village of Thadmeuang. The current system provides 90 % of Sam Neua's population with water, while the remainder of the population use river water or two local springs (ADB, 2018). Due to the high-water demand of 2,900 to 3,300 m^3/day, exceeding the sustainable yield of the Houay Hin Men and Houay Hin Dam (2,500 m^3/day), the streams experience water shortages during the dry period in April and May. These patterns will increase if the expected water demand reaches 11,300 m^3/day by 2041 (ADB, 2018).

Figure 69. Map illustrating the ADB plan.

Source: Data replicated based on ADB (2018), generated with ArcGIS (Design: ITT, 2021)



According to the water supply and sanitation project proposed by the ADB, (2018), there are plans to construct an additional raw water transmission pipe connecting a new treatment plant to the northern intake 1 km upstream of the town (see Figure 69. Map illustrating the ADB plan.). Due to recent lowering of the water levels of the Nam Xam River, the initial water intake plan for the project has been modified and now includes the construction of a weir across the full river. This would ensure a constant water supply of an additional 8,800 m^3/day, even during the dry season (ADB, 2020). The additional intake of the Nam Xam River situated upstream of the river discharging 90,000 to 170,000 m^3/day represents 10 % of the dry season flow and, therefore, will have no harmful impact on the water resource (ADB, 2018). The aim is to source additional water from the Nam Xam and supply this to the existing conventional treatment plant after its upgrade (see Figure 70. Map showing water supply infrastructure in Sam Neua town). Moreover, the existing weir at the Houay Hin Men will be extended and rebuilt (ADB, 2018) (see Figure 70. Map showing water supply infrastructure in Sam Neua town).

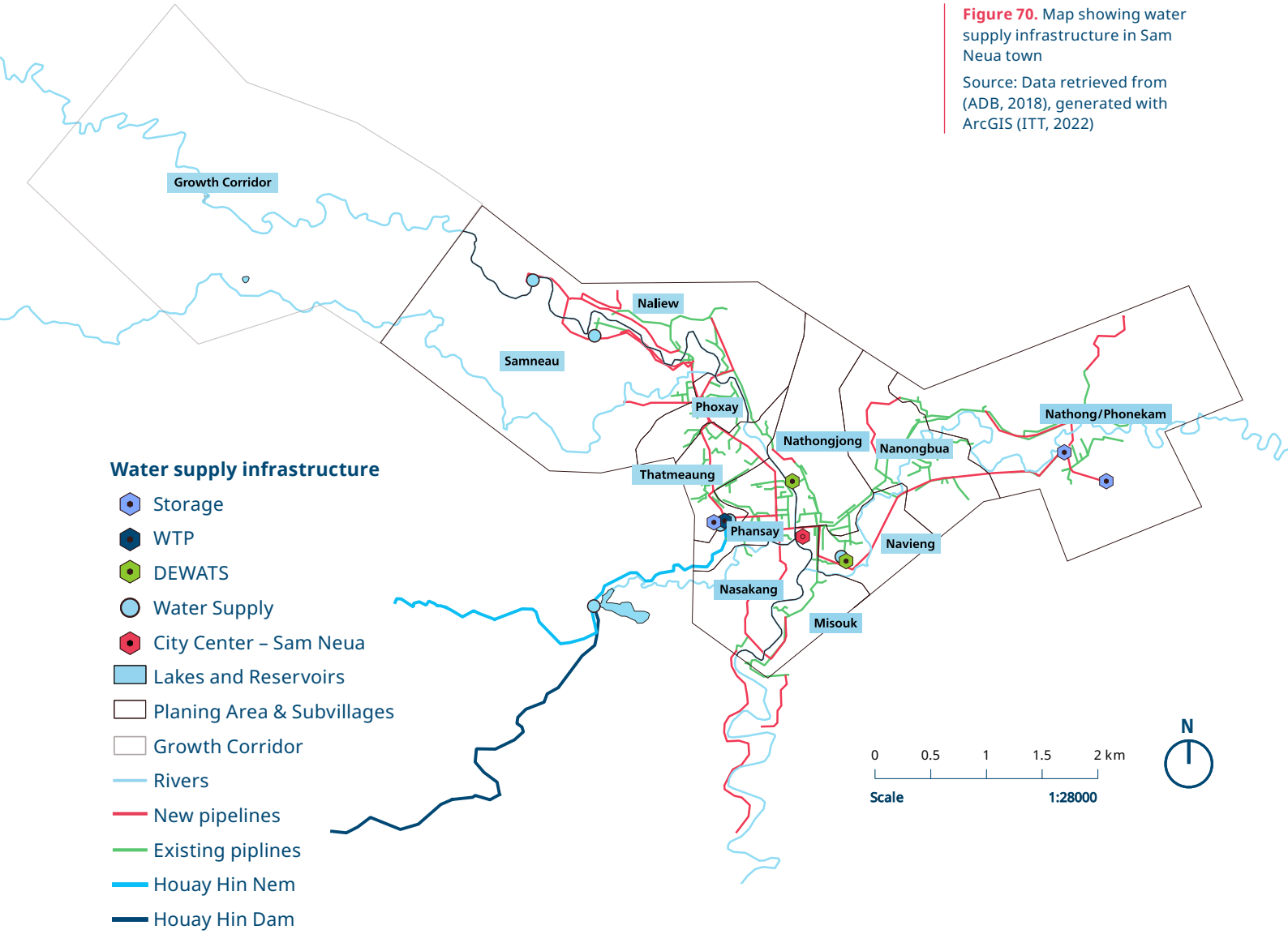


Figure 70. Map showing water supply infrastructure in Sam Neua town

Source: Data retrieved from (ADB, 2018), generated with ArcGIS (ITT, 2022)

Figure 71. New water supply intake

Source: (BORDA, 2021)

Lao PDR: Children's Vulnerability to Water-related Diseases

By 2015, under-five mortality rates had fallen to 46 per 1,000 live births (44 female, 47 male) and the infant mortality rate was estimated at 40 (37 female, 43 male) (Lao Statistics Bureau, 2018. LSIS 2017 cited in UNICEF, 2019). Despite these improvements, Lao PDR still has the highest under-five mortality rate in Southeast Asia (https://www.unicef.org/laos/health accessed 14th July 2022). The greatest share of deaths among under-fives is from neonatal causes (34 %), pneumonia (19 %) and diarrhoeal diseases (16 %).

Huaphanh Province records high levels of infant mortality and neonatal mortality at 44 per 1,000 live births, higher than the capital city, Vientiane, and Luangprabang. Huaphanh Province also records high rates of child stunting and wasting, approximately a sixth of all children suffer from moderate and severe wasting and a quarter of children suffer from stunting. Wasting indicates acute weight loss and can impair the functioning of the immune system increasing the risk of death, and stunting contributes to impaired growth and development. Both can be linked to poor nutrition and repeated infections, especially diarrhea (UNICEF, 2019; World Health Organization, 2015).

Insufficient access to improved water, sanitation and hygiene (WASH) facilities are risk factors. More than 80 % of Laotian households had drinking water contaminated by E-coli. An estimate of 24 % of all households and 33 % of rural households continue to practice open defecation. Handwashing facilities with soap and water can only be accessed by about 50 % of the population. Such barriers to improved childhood health and nutrition require substantial continued investment in both infrastructure and social change.

Storage and Capacities

For the allocation of sufficient water to Sam Neua, especially during the dry season, the town's water supply system has integrated several storage provisions, yet these have proven to be insufficient, and plans are in place to increase these capacities (See Annex. Water Supply Storage and Capacities for further details). Household respondents reported using buckets or containers as intermediate water storage in their homes (ADB, 2018, 2020).

More specifically, current water storage has proven to be insufficient throughout the most recent dry season (McNamara, 2019). To limit water abstraction from the Houay Hin Men and Houay Hin Dam and to secure their base environmental flow, especially during the dry season, the water collected from these sources is collected in a reservoir chamber, with a weir of 2 m height and 10 m length, upstream of the existing water treatment plant (ADB, 2018). Additionally, there is a water pond situated close to the Houay Hin Men & Houay Hin Dam, which can supply water in the dry season (see Figure 70).

After treatment, the water is stored in an on-site water tank with a capacity of 1,100 m^3 and an additional storage tank at the Ban Phonkham with a capacity of 30 m^3. This will be replaced with a tank of 300 m^3 capacity during the ADB funded refurbishment (ADB, 2018). Proposed upgrades to the water supply system will also incorporate an additional on-site tank of 2,000 m^3 increasing the total storage capacity at the water treatment plant to 3,100 m^3 equivalent to a reserve storage of 8 hours (ADB, 2018). Nearly all (95 %) respondents to a survey stated that they stored their water in jerry cans or buckets in their houses for intermediate water storage supply (ADB, 2018 & 2020).

No	District Name	Production Capacity (m^3/day)	Yearly total distribution Results (m^3/day)			Daily Maximum of Distribution Results (m^3/day)			
			2018	**2019**	**2020**	**2018**	**2019**	**2020**	
Ex	AAA	15 000	4 380 000	4 562 500	4 599 000	12 000	12 5000	12 6000	
1	Sam Neua	2 000	1,172,039	1,161,904	3,211	3,211	3,183	3,081	

Figure 72. Natural Pond storage for dry season
Source: (BORDA, 2021)

Table 1. Water Reservoir Distribution
Source: (Ministry of Public Works and Transport, 2020)

	Rate of Facility Utilization / Results (%)			Daily Maximum of Distribution Results (m^3/day)			Construction year	Water resources
	2018	**2019**	**2020**	**2018**	**2019**	**2020**		
	80.0	83.3	84.04	14,000	14,500	15,000		
	160,6	159,2	154,1	4,674	4,272	4,433	1999	Houaynaenm Houay-hin-dam

Water Demand vs. Supply

Measurements from the metered water treatment plant indicate that current water demand ranges from 2,900 and 3,300 m^3/day while the Houay Hin Men and Houay Hin Dam have a combined capacity of 2,500 m^3/day (ADB, 2018). This is a daily water shortage of 400 to 800 m^3. According to local authorities, water demand has exceeded supply since 2015 and deficits become apparent during the dry season. Under these circumstances, water is allocated according to distribution zones at daily time intervals announced on the television (McNamara, 2019). Future demands are forecast to increase to 11,300 m^3/day by 2041 to meet an estimated population of 35,500 people. To supply this, the additional intake at the Nam Xam River of a daily 8,500 m^3 of water shall meet the predicted water demand (ADB, 2020).

At the national level, domestic water usage accounts for 8 % of the total use, industrial demands are estimated at 10 % and agriculture as a main consuming sector requires 82 % of the total available water (WEPA, 2013).

Consumption patterns

A household survey of the water supply and its service was conducted by the operator PNP. It shows that despite 90 % of households being covered by the network, less than half of respondents were using piped water while a similar proportion were using water from 20-litre blue bottles (See Annex. Water Supply Consumption Patterns). Similarly, less than 10 % of respondents were actually drinking water from the piped water network preferring to use it for other domestic purposes.

Despite 90 % of the population connected to the network, 83 % of the local interviewees stated that they also use bottled water for cooking and drinking. The survey did not indicate why there was this preference for bottled water or why consumers were dissuaded from consuming the water from the water supply network. (ADB 2018)

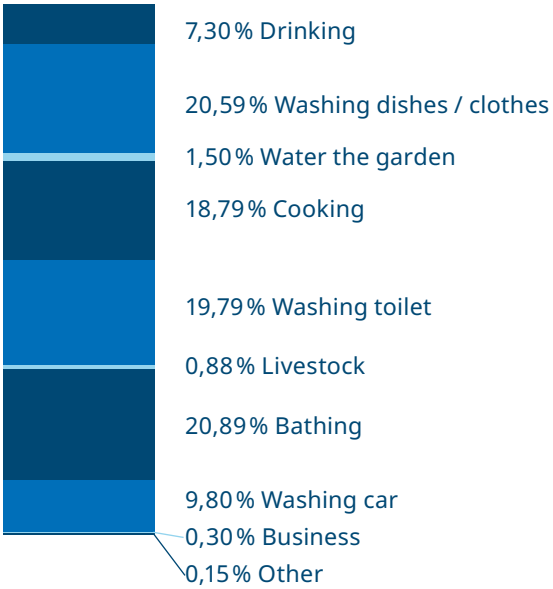


Figure 73. Different consumption patterns of the water supply service costumers.

Source: (Data replicated from (PNP, 2020)

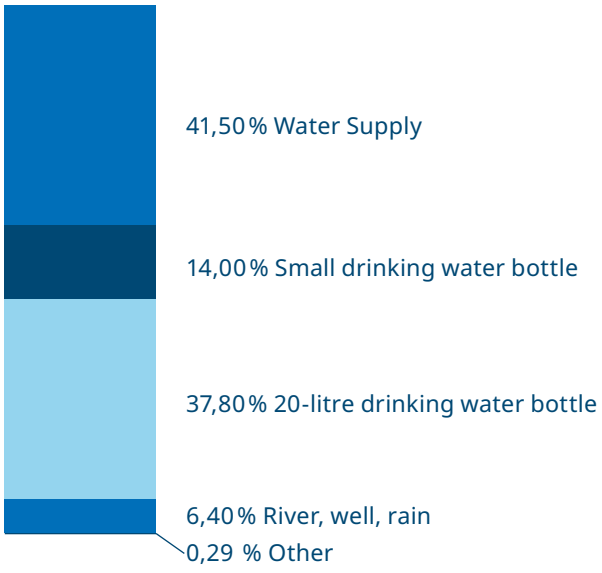


Figure 74. Different types of water use by the customers.

Source: (Data replicated from (PNP, 2020)

Water in the Town – Story 4
Bottled Water Factory

In Sam Neua District, there are seven water bottle factories that treat drinking water, bottle it and then deliver 20-litre bottles to the customers' homes. In 2020, the monthly production was 270,000 bottles, totalling an annual production of 3,2 billion water bottles (Industrial and Commerce District Office, 2020). The used bottles are exchanged for full bottles sold for 6,000 LAK per bottle. In the case of the factory assessed, the factory produces 4 m^3 of treated water per day and they sell approximately 200 bottles per day. The raw water is taken from a nearby mountain spring. The bottle factory owner leases the spring water connection from the local community at four million LAK per year. The owner explained that the French Government had donated funds to develop the pipe system to extract the spring water. He went on to explain that the communities did not have the capacity to manage the piped system, so he had leased it from them to use the water for his factory. In the piped system delivering the water to his factory, there are six filter points down the mountain to his factory from the source of the spring in another village. At the factory, the water is then treated again using reverse osmosis with ultra violet and ozone. The quality of the water is monitored every three months and there are unannounced inspections of the quality of the bottled water and the water treatment facility by the Department of Health (Interview with UDAA, BORDA 2022 and Interview with Business Owner, (BORDA, 2022a).

Figure 75. Drinking water delivery service for 20-litre blue bottles at 6,000 LAK per refilled bottle

Source: (TUB, 2022)

Water in the Town – Story 5
Residences

This female interviewee lives in Sam Neua Village with five members of her extended family: her three grandchildren and their employed parents. She used to be a government official before retirement. Her house is quite small and situated on the hill above the Nam Xam River. They pay between 80,000 and 120,00 LAK per month for the piped water supply and use it for washing and cleaning and they use about three to five 20-litre blue bottles a week for cooking and drinking at a cost of 6,000 LAK per bottle. Their only toilet discharges to a two-chamber septic tank, and she explained that only the blackwater went into this tank with its sealed walls. The tank is reported as approximately 1.5m by 3m with a depth of 1.8m, and is situated directly under the toilet at the back of the small house. The bathroom is about ten years old and needs little maintenance apart from regular cleaning. The septic tank has only been desludged once and this cost 500,000 LAK for the small vacuum truck to come and the operators to remove the toilet pan so that the pipe could be inserted to suck out the sludge. This inconvenience seems acceptable to the family. Greywater is discharged directly to the local open drain running outside the house. The family also collects rainwater via a converted piece of corrugated iron directing rainwater into a large plastic barrel. They use this water to supplement the piped water supply because it is free to collect and use (Interview with Home Owners, BORDA 2022).

Figure 76. Female Interviewee's Home and Wastewater Management

Source: (PUW Field Trip, 2022)

Distribution Infrastructure

Approximately 90% of Sam Neua town's 18,187 population is covered by the piped water supply system Department of Water Suply, 2020 Current water supplies are connected to the existing water treatment plant (ADB, 2018). Distributions to connected households occur via an existing pipeline network that operates on a gravity pressure system and is equipped with high-density polyethylene and polyvinyl chloride pipes. Through the current development project of the ADB (2018, 2020b), the water distribution will be designed as two distinct systems incorporating four metering areas monitored by bulk meters. They will serve approximately 800 to 1,000 connections each through a total of 12.5 km of gravity fed, pressurized reticulation network of polyvinyl chloride and polyethylene pipes to all 12 villages. To meet the future water demand, the network upgrade will establish 800 new connections: 745 domestic, 15 institutional and 40 commercial connections (McNamara, 2019). According to local authority statements in 2019, the complete water supply system of Sam Neua is a state-owned enterprise that charges approximately 3,500 LAK/m^3 (ADB, 2018, 2020; McNamara, 2019).

Alternative or Informal Water Supply Systems

Relatively few people are using wells or other sources as informal water supply systems and spring water is used for bottled water production. The Nam Papa of Sam Neua (SNP), together with the province and district, raise awareness among communities of the risks of using informal water supply systems.

Nevertheless, the household water use survey indicates that some households collect their water (72%) as they do not have access to the piped network or prefer free water. Generally, the respondents stored their water in large containers or buckets to use it for cleaning, washing and bathing (see utilization patterns above) (PNP, 2020). Before the water supply network was established, all the households relied on rainwater harvesting as a water supply, and this was still observed in some households. In the agriculture sector, the water from the river or streams is sometimes used for livestock or for irrigation.

Figure 77. Informal water source in Na Vieng Village, water piped from the mountain

Source: (BORDA, 2021)

Figure 78. Informal tapping of stream water through plastic pipes

Source: (BORDA, 2021)

Water Quality

The catchments of the Houay Hin Dam and Houay Hin Men are characterized by steep sides along the tributary with forests located upstream keeping water turbidity respectively low (ADB, 2018; Department of Water Supply, 2018). Furthermore, the catchment area is a protected water source managed by the PNP and DONRE. Within the ADB project, the PNP is conducting regular monitoring of the raw and treated water sources to meet the guidelines for environmental management as well as the EHS Guidelines for Water and Sanitatio[1]. The ADB recognise that better capacities are required for monitoring water quality so that the water treatment practices meet the standards of the Ministry of Health. The drinking water quality is assured by regular tests and monitoring of 23 parameters, with seven key parameters tested weekly and 14 others on a yearly basis (ADB, 2018).

1 Environmental, Health and Safety Guidelines of World Bank Group (link)

Water in the Town – Story 6
Car Wash

The survey team observed at least three car wash businesses in the urban area. For example, the shop visited receives three to five cars at the same time. The shop reported that washing water is sourced from the piped water network. The water bill for March 2022 recorded water consumption of 81 m^3 and a cost of 600,000 LAK. The car wash charges between 40,000 LAK to 60,000 LAK per car depending on the car types. Used washing water is directed to a sand screen for the operator to trap and collect sand, soil and other residues before being discharged to the drain. This used washing water contains oils and detergents, which potentially increases pollution of surface water if poorly managed. The car wash does not have any treatment facility to reduce the discharge of oils and other chemical residues into the environment (Interview with Business Owner, June, 2022; BORDA, 2022a).

Figure 79. Wastewater Management and Price List at the Car Wash

Source: (PUW Field Trip, 2022)

The Ministry of Health (MOH) issued the Water Quality Standard for the Management for Drinking and Domestic Use in March 2014 in accordance with Decision 561/MOH, 2014 (ADB, 2018). According to these standards, monitoring should occur on a weekly, monthly or annual basis according to the tested parameter. Maximum limits for drinking water standards are also outlined. Despite this, there is insufficient laboratory water quality testing infrastructure available making reliable testing complicated as testing and analysis has to be conducted in Thailand. The operator of the local water supply network tests the pH, turbidity and residual chlorine once or twice a year (ADB, 2018). Neither the results of these tests nor the water quality measurements from the DOI are provided in publicly available reports. Water quality results from 2017 are reported by the ADB (2018), and show a water quality suitable for conventional water treatment (See Annex. Water Quality Results from May and July 2017 for details). It is noted that a conventional rapid sand filter will keep the turbidity of Houay Hin Men and Houay Hin Dam low to about 1 NTU (ADB, 2018).

Drinking water is conventionally treated using gravel, sand and charcoal filters at the local water treatment plant (ADB, 2018). For the proposed upgrade of the treatment and supply system, hydraulic mixing, sedimentation followed by rapid sand filtration and disinfection with powdered chlorine will guarantee that drinking water standards are met.

An ADB survey (2018) indicates that those who drink water from the water supply network usually boil it before drinking it.

Water in the Town – Story 7
SOS School and Children's Village

The SOS School and Children's Village was built above the Nam Xam River in Nailew Village close to the main road. The director explained that they are a charity providing education and residence to 150 poor and orphaned children. The building began in 2003 and it opened in 2006. The centre pays approximately 6 to 7 million LAK per month for the piped water supply for cleaning and washing (5 to 6 million LAK for the residence and 700 thousand LAK for the school). The centre also buys bottled water for drinking and cooking at 280 bottles per month (260 for the residence and 20 for the school). In the centre, there are 19 toilet blocks for both boys and girls, and there are 16 houses (12 for the children, four for the staff, and one for guests). Blackwater is discharged into septic tanks below each building and are annually desludged at a cost of 18 million LAK. There is a member of staff who is tasked with maintaining the school toilets and the children are responsible for cleaning the toilets in their residence Greywater from cleaning and bathrooms is discharged to the drain and then to the nearby river. Sometimes the users complain that the toilets or drains smell during the rainy season (Interview with School Director, BORDA 2022).

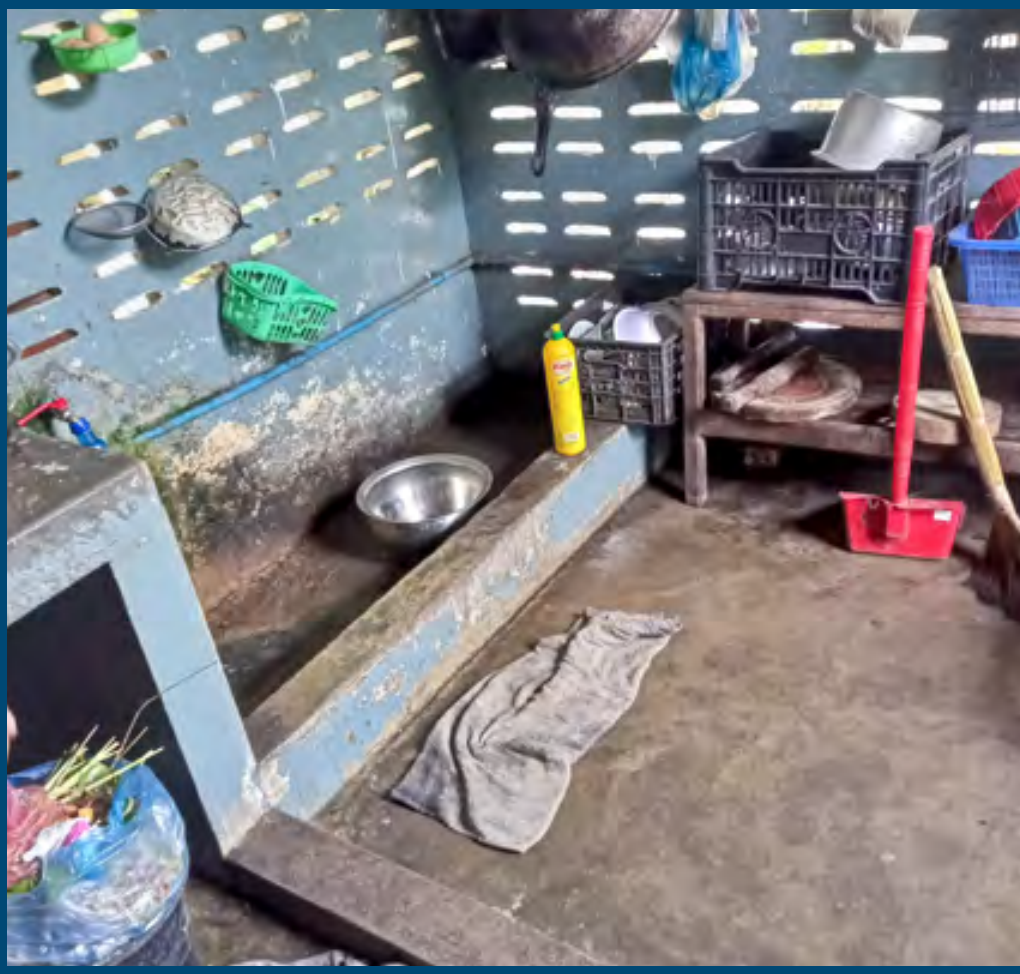
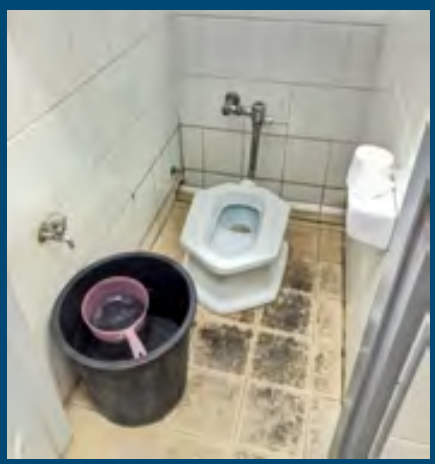


Figure 80. SOS School and Children's Village

Source: (PUW Field Trip, 2022)



Key Risks to Water Supply in Sam Neua

Sam Neua's Water Supply is at risk from two key factors:

Water losses and shortages: Currently, the town's water supply network experiences non-revenue water of about 36 % and the local agency aims to reduce losses by 7 % by 2022 through improved non-revenue water management. To prevent water losses, an ADB project will survey and replace pipes as required. Furthermore, installation of water meters at the distribution and secondary networks will measure the amount of water running through the system, and every household will be checked for water leakages followed by repairs to prevent further water losses. Furthermore, current work to expand the water network with additional water sources will contribute to reducing water shortages in the dry season due to over-extraction from the rivers.

Water pollution: Despite the water being treated and regularly monitored before it is supplied to the customers, the pollution of the water sources and the environment can pose a health risk to the public and the environment. The high density of fishponds represents a pollution risk for open water bodies in the event of overflow and flooding. Their organic matter, suspended solids and – depending on whether fertilizers are used – antibiotics or other chemicals can lead to contamination and eutrophication of fresh water bodies (Boyd, 2011). Furthermore, the use of fertilizers and pesticides in the cultivation practices of paddy fields can be washed into water sources by heavy rain and erosion events. The close implementation of sanitation to ground- and open surface water bodies, as well as the disposal of faecal sludge and wastewater to open areas represent a constant pollution threat to drinking water resources.

Future Service Demand and Supply Projections and Plans

Projections from the PNP for 2022 show an increase in domestic and industrial water use. These current estimates suggest that more staff and resources will be needed in the future as the PNP will focus on technical capacity development in cooperation with the DWS. Furthermore, reform programs are planned and aim to improve efficiency, transparency, accountability and sustainability. Financial assets are projected to grow to over 173 billion LAK by 2022, largely driven by capital investments for new supply systems, including the one in Sam Neua, and will increase productivity capacities to 20,850 m^3/day. By 2022, the water supply network will cover 483 km with a water production of about 2.6 thousand m^3 compared to 1.9 thousand m^3. At the same time, there will be an increase in the percentage of PNP financing to 35 % and 15 % in different parts of Sam Neua. The predicted deficit for 2022 is 558 LAK/m^3 and will lead to an already approved tariff adjustment that will likely reduce the current deficit to 0.2 billion LAK in 2022 (Ministry of Public Works and Transport, 2018).

Potential Water-Sensitive Solutions

To reduce pressures on the infrastructure system in the high-density built-up area in Sam Neua and to respond to water shortages, exemplary calculations for selected town blocks in Sam Neua with a high-density area present the opportunity to use rooftop surfaces in a water sensitive manner. If all roof areas would be used to collect water, over one year, **8,716,000 litres** of water could be harvested. This means that if only 20 % of the houses used their rooftop surfaces and practiced water harvesting, a potential maximum of 1,743,200 litres could be collected and reused every year. (See Annex. Rainwater Harvesting from Roofs in High Density Areas for further details)

Rainwater Harvesting Examples

While rainwater harvesting is no longer commonly practiced, there was evidence of households choosing to supplement their piped water system with rainwater to support their living and household businesses, particularly for cleaning. These took the form of simple corrugated iron sheets fashioned to direct rainwater to large containers. In one observed case the household had purchased two metal water tanks and used blue plastic piping to direct rainwater into the tanks.

Figure 81. Examples of Rainwater Harvesting
Source: (PUW Field Trip, 2022)

Mandate for Service Provision

In 1999, Prime Minister Decision No. 37 on Management and Development of Water Supply and Wastewater Sector defined the government's coordination and development role. The Ministry of Public Works and Transport (MPWT) with the support of the ADB and UN-Habitat in 2012 developed a strategy with the aim of ensuring the provision of piped water and sanitation services to emerging towns. The Department of Housing and Urban Planning adopted the main Sector Strategy with Resolution Three of the Politburo in 2012. This ensures the inclusion of emerging towns into the Water and Sanitation Sector Strategy. In line with decentralization policies, responsibilities for water supply and sanitation lie with local authorities, with management carried out by provincial water utilities operating as state-owned enterprises.

Under the MPWT, there was the creation of the Department of Water Supply (DWS) in 2016 followed by the development of an overarching water and sanitation policy revision of existing strategies, and restructuring of the institutions to improve coordination and communication.

The 2013 Urban Water Supply Strategy includes the emerging towns' development goals and the "Water supply and Sanitation Sector Strategy". With the development of a Water Supply Policy in 2016, these strategies were further revised and merged (UNDP-SIWI, 2017). As a result, the Water Supply Unit is under the Sector of Housing-Urban Planning and water supply (SHUP) (DPWT_Huaphan, 2019).

Moreover, to implement a decentralized approach, a state-owned enterprise called Nampapa Lakhon Luang was established with the responsibility for coordinating the water supply in Vientiane district. In the respective provinces, the state-owned enterprise Nam Papas (PNPs) operates the water supply system, called the Provincial Nam Papa' (PNP HPAN) in Houaphan Province (UNDP-SIWI Water Governance Facility, 2017). It aims to provide treated water to all consumers within the urban area at a reasonable rate. The utility provider is overseen by a board of directors chaired by the Provincial Vice-Governor (MPWT, 2018).

Key Roles and Responsibilities

Provincial Nam Papa Houaphan Province (PNP HPAN) (MPWT, 2018)

The PNP HPAN is responsible for regular reporting, monitoring of ten performance indicators, collecting water tariffs, external reviews and audits, consumer communication, sustainable financial performance and the inclusion of the poor. Furthermore, the PNP cooperates with the housing-urban planning and water supply sector (SHUP). The Water Supply Unit in the SHUP is responsible for its expansion policy, strategy plan and development plan, as well as a publication of decrees, laws, standards, new methods and technology, regulations related to water supply/sanitation, infrastructure construction orders, monitoring and inspections, statistical data collection, interdepartmental collaboration, conflict resolution, and reporting (DPWT_Huaphan, 2019).

To promote community engagement, there is a water supply campaign in villages, and schools, and random awareness raising activities with specific households on water supply at the household level. Further support is provided through the display of posters, including key messages (Interview with Sam Neua Nam Papa management officer).

The MPWT is broadly responsible for maintenance and service provision while a number of specific agencies are responsible for management and monitoring infrastructure. For example, the provincial-level Project Implementation Unit is responsible for land acquisition and compensation plans, access road design, identification of baseline water quality, river level, flow and assessment, monitoring of contract work activities, health and safety provision monitoring, and complaint reports. The PNP is responsible for river level and flow assessment, clearance, environmental compliance construction monitoring, removal of artifacts, household monitoring, water quality and pressure monitoring, professional training, detention pond monitoring, and security. The DPWT is responsible for environmental compliance and project specific contractors are tasked with managing mitigations and rehabilitations. Environmental monitoring reports are a shared responsibility between the individual contractors, MPWT, provincial-level Project Implementation Unit, national-level Project Coordination Unit, and the PNP (for more information see ADB, 2018).

Financing

Capacity and infrastructure development schemes are funded through external development partners (MPWT, 2018). Sam Neua's water supply system was built in 1997 under the ADB project 'Northern Provincial Towns Water Supply' (MPWT, 2018). PNP capital investments in Sam Neua were funded by the National Government (1977) and the ADB (1999 & 2006). There are currently two subsidiary loans (1999 – 2029 & 2013 – 2032) for the Sam Neua District from the Ministry of Finance, which have respective interest rates of 6.64 & 6.4 % (Ministry of Public Works and Transport, 2018).

PNP HPAN has a budget plan with a total capital investment of 118.72 billion LAK for the new water supply system. The majority of the investment is covered by external funding from the ADB (70%), PNP covers 5 % of the expenses and the government 25%. Note that these numbers are for all Houaphan Province (Ministry of Public Works and Transport, 2018).

Water Tariffs are regulated and approved by the provincial government and parliament based on technical advice and support from the MPWT and specifically the Department of Water Supply (Ministry of Public Works and Transport, 2018). The tariffs secure the PNP HPAN's coverage costs and are adjusted every year according to the growing water demand (Ministry of Public Works and Transport, 2018). Customer tariffs are at a standard rate across the province within certain categories: residential, government, commercial and industrial. The residential tariff is structured according to the water demand from basic water supply to higher consumption levels, so that they are affordable for low-income households. In general, households display a distinct willingness to pay the current price (Interview with UDAA and DPWT, PUW 2021).

In 2017, domestic water sales in the province made up around 72 % while 10 % were supplied to institutions, 13 % to commercial businesses and 5 % to industry. The financial assets during that year were over 55 billion LAK, and the PNP was able to cover operation and maintenance costs (Ministry of Public Works and Transport, 2018). Net average revenue of the PNP in 2017 was 5,064 LAK/m^3, with net average core operating expenses of 6,644 LAK/m^3. From 2019 to 2020, the overall adjustments were 3 % annually for domestic customers and 5 % for non-domestic customers (Ministry of Public Works and Transport, 2018).

Water in the Town – Story 8
Government Institutions

The assessed government institutional buildings are typical of how these types of buildings are managed in terms of water supply and wastewater. The new Labor and Social Welfare Department building, the new Office of Public Works and Transport building and the old Social Security District Office have 46 staff, 6 staff, and 65 staff respectively and the Social Security District Office also houses as many as 20 prisoners all regularly using the toilet facilities. Each institution uses the piped water supply: 30 m^3 , 3 to 5 m^3 and 100 to 120m^3 per month respectively, and this is paid by the provincial government. In all buildings, the piped water is used for general cleaning purposes and is discharged into the open drains and then into the nearby rivers or infiltrated into the ground. For the new Labor and Social Welfare Department and the Office of Public Works and Transport buildings in Sam Neua Village, this greywater is discharged in close proximity to the water intake for the town's piped water supply system and, in fact, a simple presence and absence E-coli test indicated its presence.

There are 12 toilets, 2 toilets and 12 toilets respectively at each site. The blackwater at all sites is discharged to septic tanks located outside or in one case under the building, and for the newer buildings in Sam Neua constructed in 2014 and 2018, these septic tanks have never been desludged. However, in the case of the older Social Security District Office building, some of the septic tanks constructed in 2012 are broken and cause pollution of the nearby ground and drainage system. The officials explained that they did not check the septic tanks unless there were problems, and in the case of the Social Security District Office, it was explained that one septic tank has to be desludged two to three times per year due to it becoming blocked, but they explained that they lacked the budget to adequately repair that broken septic tank with it continuing to leak into the environment. At the new Labor and Social Welfare Department building, officials complained that there were sometimes unpleasant odors emanating from the toilet after flushing (Interviw with Government Representatives at Sites Visited, BORDA 2022).

Figure 82. Wastewater Management at Government Buildings

Source: PUW Field Trip, 2022

Wastewater Management: Containment, Treatment and Conveyance

Key Messages of Section

Sam Neua's **local authorities recognise the crucial importance of effective and efficient wastewater treatment for the sustainable development of the town, the National Socio-Economic Development Plan**, and the localisation of the **SDGs**.

As Sam Neua town grows, more water will be used and significantly more wastewater will be generated. Already today, **inadequate management of wastewater** (septage, household greywater, and agricultural/industrial wastewater) contributes to increasing risks of contamination, water resource pollution and potentially higher rates of water-borne disease infections.

The widely used **septic tanks are poorly designed and rarely emptied** indicating potential pollution of the environment, and when emptied, **faecal sludge is disposed untreated** in paddy fields, on roadsides and at solid waste dumpsites.

There is **no mechanism for greywater retention and treatment**. This results in pollution of surface and ground water.

Solid and toxic waste is poorly managed and disposed of causing potential pollution of water sources and public health impacts.

Due to the limited financial and institutional capacities, for the foreseeable future S**am Neua will not be able to finance and maintain a high-tech sewage system**.

In this context, a pathway of **progressive implementation** should be followed, based initially on **improved septic tanks, DEWATS clusters and comprehensive sludge management, and later followed by more complex systems.**

Effective urban drainage has a significant impact on the **effectiveness** of wastewater systems. By **reducing stormwater** run-off through surface infiltration and through **separated** stormwater/wastewater systems, the **uncontrolled flushing** of wastewater systems can be prevented and the necessary technical **treatment capacities** and c**onstruction costs** reduced.

Initiatives to re-use recycled water in different sectors and **raising awareness of using water in a sustainable manner can be part of increasing wastewater treatment capacities**.

There is **no specific standard for wastewater discharge in Lao PDR** making it more challenging to develop an **enabling environment** for effective **wastewater treatment**.

Law enforcement at the household level and monitoring of adequate disposal of sludge at treatment sites are lacking for effective sludge-management.

Wastewater cannot be successfully managed without **the establishment of effective maintenance and operation schemes**.

Wastewater Management in Sam Neua

The increasing depletion of surface and ground water quality has a number of causes, including pollution of water bodies by agricultural production, discharge of highly BOD loaded wastewater from slaughterhouses and food processing, discharge of insufficiently treated domestic wastewater and the poor management of hazardous liquids and waste from oil, clothing dyes, medical chemicals and waste, and batteries among others. However, at the root of these causes are some common themes: legal loopholes and insufficient monitoring capacities, lack of financing, and a lack of knowledge and appropriate treatment technologies.

While many of these forms of pollution and contamination are still at limited scales, with the expected urbanization trend and anticipated increase in the local population combined with these root causes, Sam Neua's vision of a 'green, clean, beautiful and peaceful' place to live may not be realized. If Sam Neua's water bodies become polluted and contaminated, the local economy and people's livelihoods in terms of agriculture, aquaculture and tourism will be affected while the increased exposure to this poor-quality water will adversely affect the population's health adding a further socio-economic burden to the population and local government to manage (See Figure 83).

Wastewater Generation Patterns and Treatment

For urban planning decision-makers to integrate existing urban areas with new areas, an understanding of the wastewater produced by households, businesses, industry and government institutions is required. Estimates for wastewater discharge from the 12 villages in Sam Neua are just over half a million m^3 per year (See Annex. Estimated Annual Wastewater Discharged in Sam Neua – Figure 70) (BORDA, 2022c).

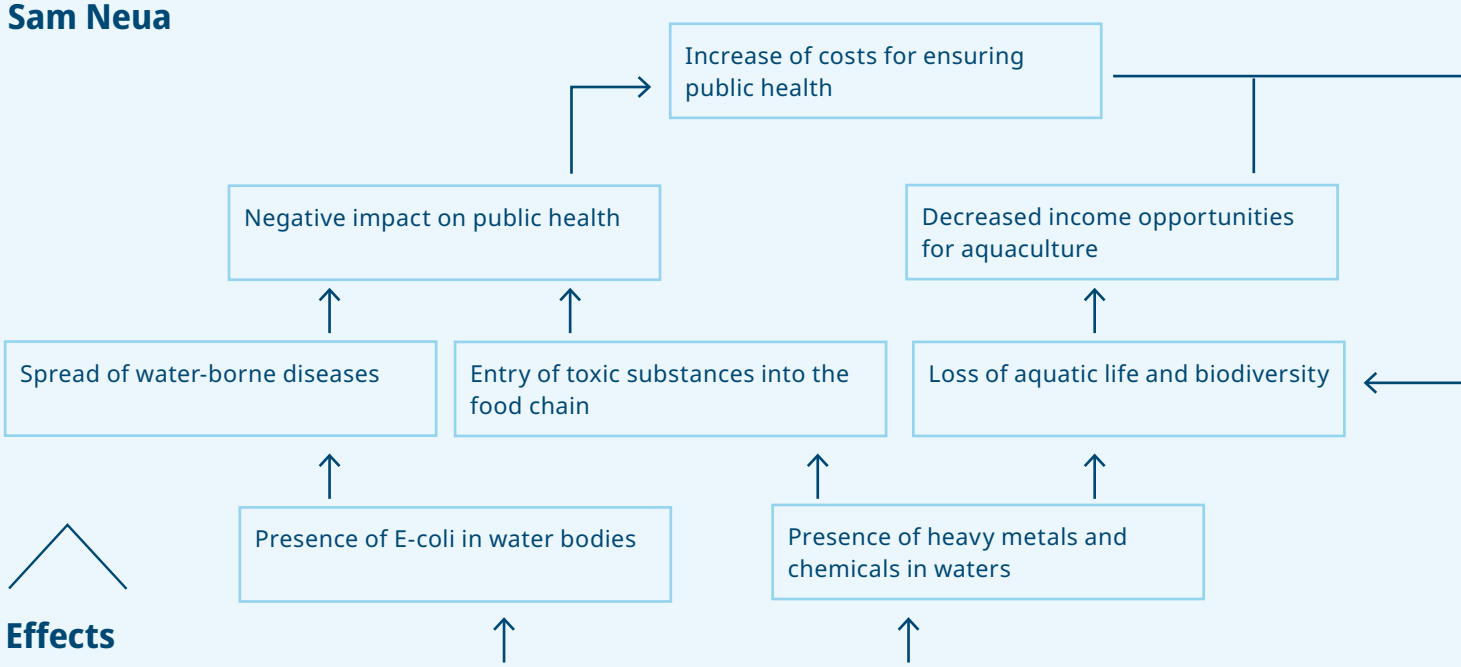
According to the government, the vast majority of Sam Neua's population has access to water and sanitation (90%) although the reliability of these services throughout the year cannot be guaranteed. A survey conducted by the Department of Housing and Urban Planning (DHUP) indicates that all the town's households have access to individual household toilets (90% septic tanks and 10% pit latrines) as well asits 113 commercial, institutional and industrial buildings (DHUP, 2020).

Existing soak pits connected to pit latrines or septic tanks are mostly unsealed at the bottom and situated relatively close to water sources (BORDA, 2015). Moreover, the septic tanks are described by the local government as following official construction guidelines and so are intended to be fully lined with impermeable walls but unsealed bottoms (DHUP, 2020). Depending on the standard used for calculation, estimates for Annual Faecal Sludge Accumulation in Sam Neua vary from over 700 to over 2000 m^3 per year (See Annex. Estimated Annual Faecal Sludge Accumulation in Sam Neua) (BORDA, 2022b).

In Sam Neua, as with other secondary and tertiary Laotian cities, there is no efficient wastewater treatment system as the residents and producers of wastewater have traditionally relied upon the existing waterways that flow down through the town and discharge into the main rivers. Such a system carries greywater from bathing, cooking, washing and laundry activities. Experts note that it is likely that septic tanks are leaking faecal matter causing it to infiltrate into the ground and onwards into the streams and downstream rivers. Untreated sewage, wastewater and faecal sludge, consequently, is discharged through open drainage channels to the surface water bodies, such as the Nam Xam River (Ulrich et al., 2009).

For Laos PDR, annual health-related costs of poor sanitation were estimated to be in excess of 1.19 million LAK per household in both rural and urban areas. (World Bank, 2013)

Problem Tree: Wastewater Management Sam Neua



Problems

Increasing depletion of surface and ground water quality

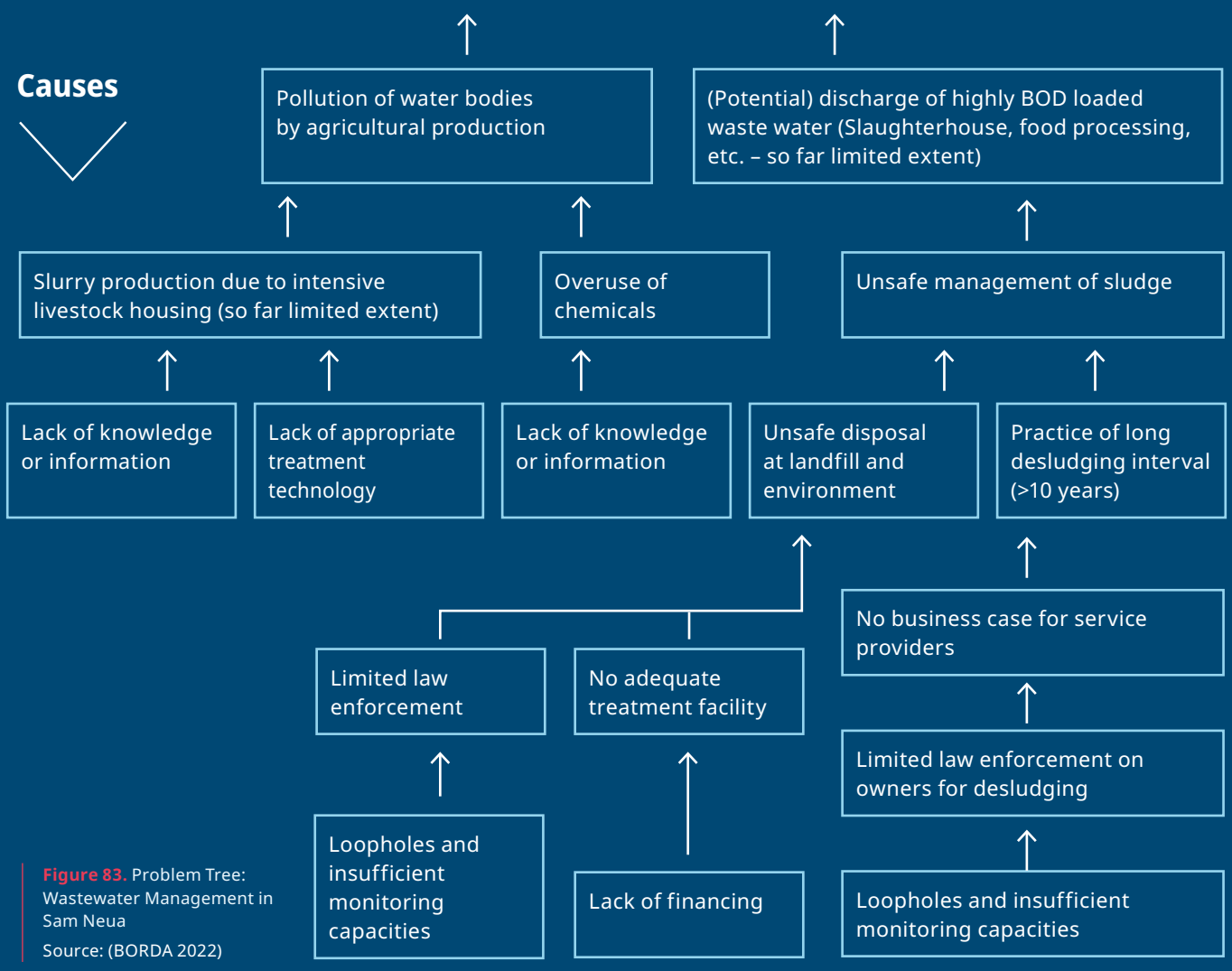
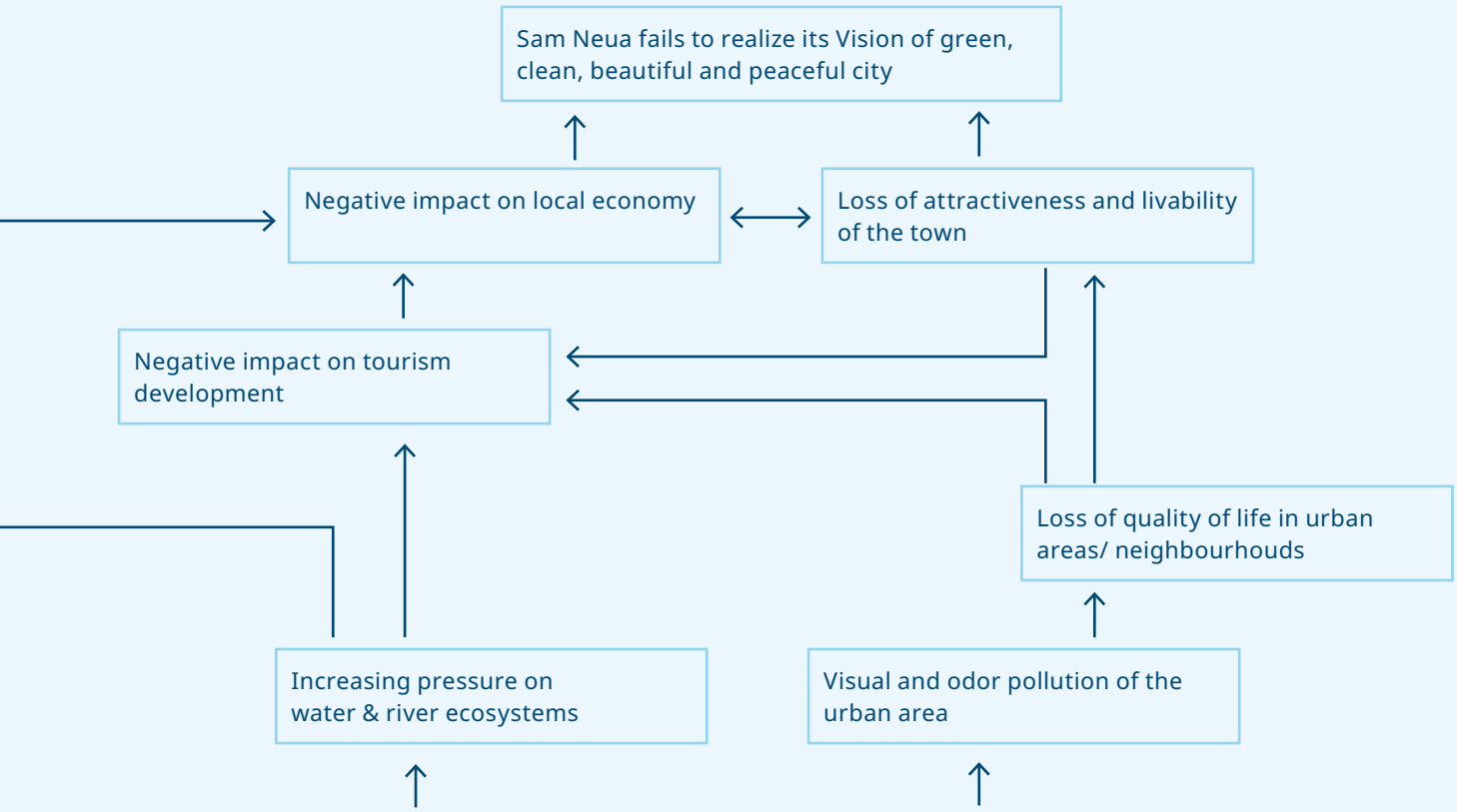
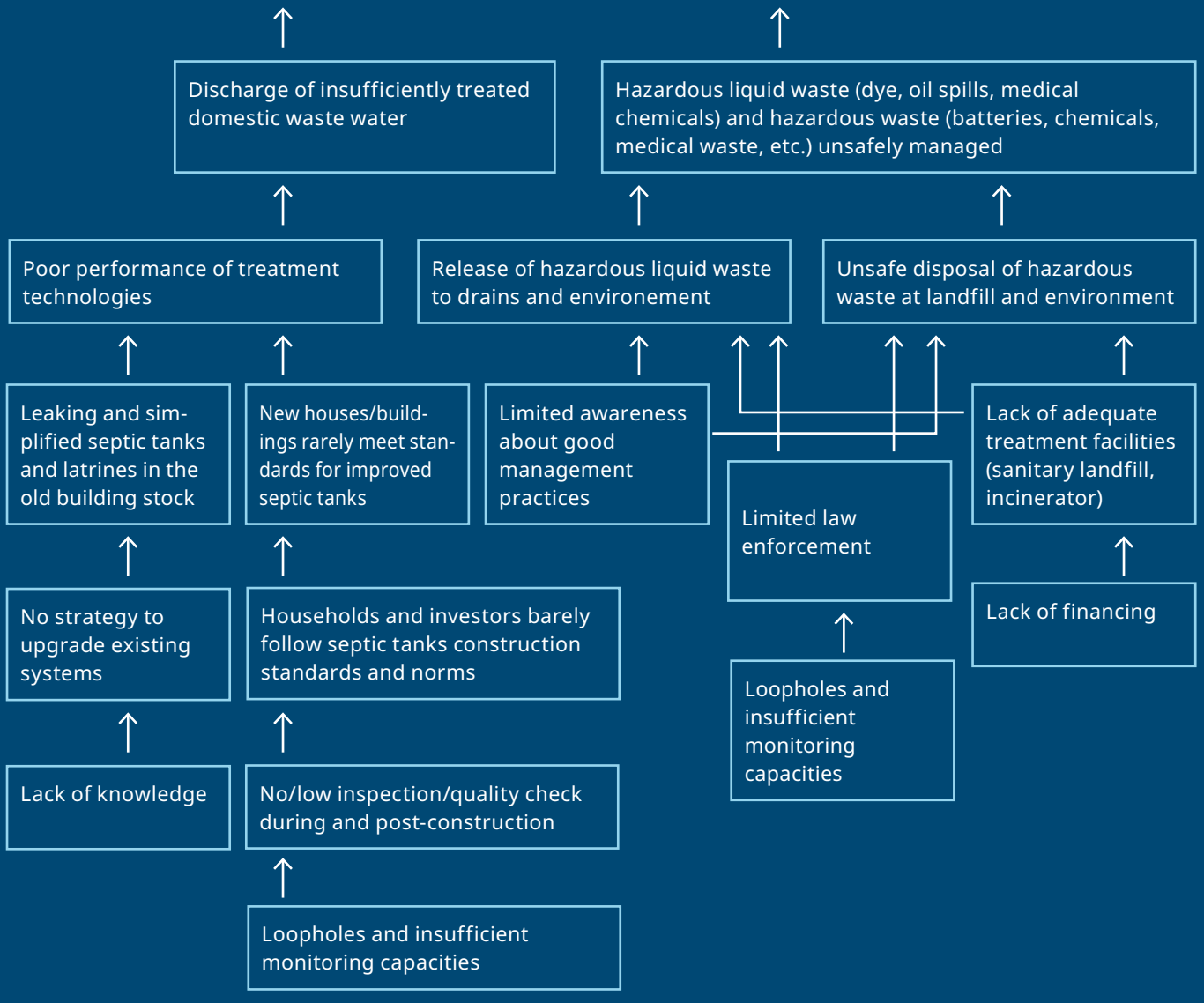


Figure 83. Problem Tree: Wastewater Management in Sam Neua

Source: (BORDA 2022)



Increasing depletion of surface and ground water quality



Water in the Town – Story 9
Slaughterhouse

In Sam Neua, the wastewater from slaughtering animals is not treated and released untreated into the existing wastewater drainage system. Specific quantified data is not available for these processes at the time of writing. However, Sam Neua will soon have a new abattoir with a daily slaughtering capacity of 40 pigs and 15 cows. The Department of Agriculture and Forestry has initiated and is leading the project. The facility will be erected on a 200 m^2 area and have a decentralised treatment facility to receive and treat nearly 15 m^3 of wastewater discharged from slaughtering activities. Abattoir wastewater contains highly concentrated organic pollutants from animals' blood, dung and intestines, urine, and washing water from cleaning the slaughtering facility. The wastewater treatment combines a settler, an anaerobic baffled tank, an anaerobic filter, and a planted gravel filter. Treated wastewater will be released to the environment through a constructed wetland if it meets the discharge standard. The project has gone into the bidding process, after which construction will start once the winning bid is announced. Source: (BORDA, 2022)

The National Environmental Standard 2017 details standards for controlling water pollution from toilets and for water pollution control from general industries (See Annex. National Environment Standards 2017 – Standards for Controlling Water Pollution from Toilets & Annex. National Environment Standards 2017 – Standards for Water Pollution Control from General Industries for details). For toilet and general industry wastewater, the BOD of 30 mg/l, total suspended solids (TSS) of 50 mg/l, and COD of 125 and 120 mg/l respectively should not be exceeded.

Pollution of surface waters in the catchment area caused by livestock farming is not yet an urgent problem in Sam Neua. Livestock is mostly kept in extensive pasture farming with pigs in smaller stables. Since these agricultural activities are in the upstream area of the catchment and there is a high dilution capacity of the waters, the impact on water ressources are limited. The increasing intensive use of fertilizers in agriculture can lead to water pollution. Excessive and frequent fertilizer applications, often in conjunction with incorrectly chosen timing, mean that not all nutrients can be absorbed by the plants or stored in the soil, but are washed out by rainwater and runoff. The nutrients that are washed out end up in surface waters and groundwater and in some cases significantly impair water quality. Monitoring is needed by authorities and communities to avoid significant contamination.

Faecal Sludge Containment and Treatment: Septic Tanks, Seepage Pits and Pit Latrines

Most, if not all, households in the urban area dispose of their wastewater from toilet sources into a septic tank. The toilet facilities can be inside the house or located outside or separated from the main house. The toilet has a squat toilet pan and a bucket of water with ladle for washing and flushing. The blackwater containing faecal matter and washing water is disposed of in the septic tank. The greywater contains washing water and detergent/soap materials and is discharged to the drain.

Of those assessed, the typical septic tank is large, and in some cases, shares a wall structure with the toilet facility. The septic tank contains two to three chambers and only receives blackwater. The septic tank's length ranges from 3 m to 4 m with a width of 1.5 m. The tank depth ranges from 2 m to 3 m. With the expected volume ranging from 9 to 18 m^3.

Due to the lack of government regulations and enforcement capacity for appropriately managing faecal sludge, a septic or latrine containment tank is only emptied when the owners are inconvenienced by no longer being able to flush their toilets because the containment tank is full or even overflowing. As a result, respondent households explained that sludge was removed once every 10 to 20 years if at all (Interview with House Owners, BORDA 2022). The so called "Current Flow Diagram" developed for Sam Neua indicates that less than 1 % of faecal sludge is emptied, and this is disposed untreated (See Figure 84).

The majority of Sam Neua's urban population use private toilets with septic tanks, and depending on the available space, the design of the septic tanks may differ. In the high-density area with limited space available, the septic tank is constructed with three chambers. The wastewater flows into a two-chamber settlement tank, followed by a third chamber where different layers of gravel, sand and charcoal filter the wastewater (See Annex. Detailed Design of a Septic Tank & Design of a Seepage Pit). The effluent from the septic tank is discharged into the local drainage channels.

Flow Diagram: Current Faecal Sludge Managment Sam Neua

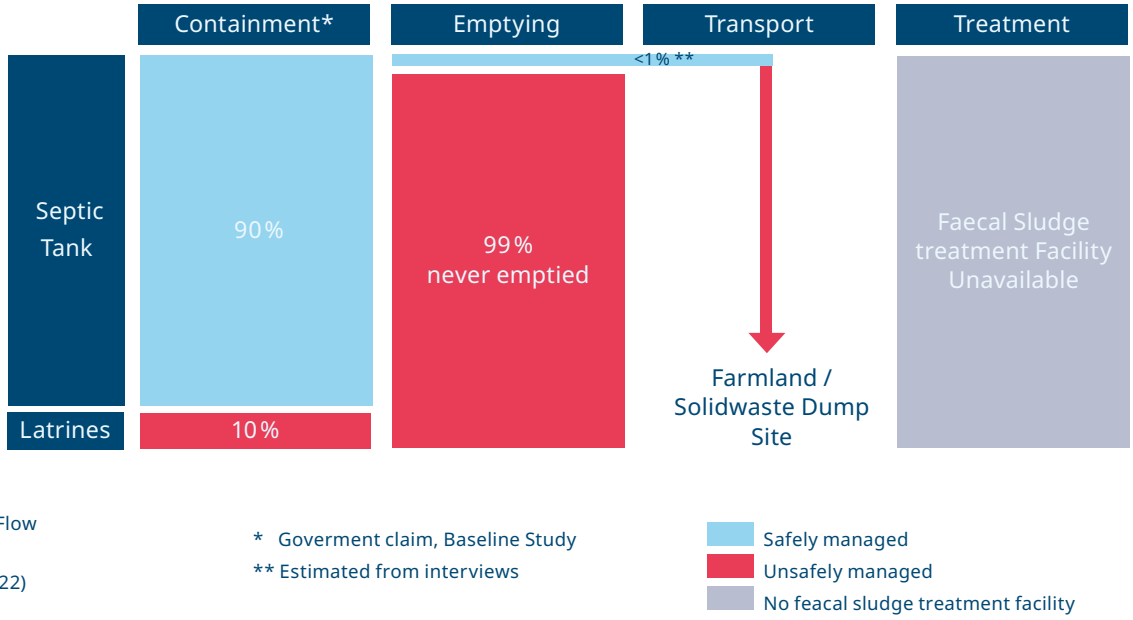


Figure 84. Current Flow Diagram
Source: (BORDA, 2022)

Figure 85. Examples of toilet and septic tank construction

Source: (PUW Field Trip, 2022)

Figure 86. Example of septic tank that is common in the area

Source: (PUW Field Trip, 2022)

Figure 87. Rings used for septic tank with greywater pipe

Source: (Water and Sanitation Program, n.D.).

However, it should be noted that most septic tanks do not meet the construction design standards shown in the Annex. Detailed Design of a Septic Tank & Design of a Seepage Pit. As a result, many are not appropriately sealed contributing to blackwater leaking into the environment (See Figure 78).

In less densely populated areas, for example the extension and rural areas, treatment of the effluent is performed by a seepage pit (see Annex. Detailed Design of a Septic Tank & Design of a Seepage Pit). The seepage pit is made out of a concrete ring with a diameter of 1000 to 1200 mm. Holes along the sides of the rings allow the wastewater to percolate through the ring into a mixed gravel layer enveloping the ring. This outer layer consists of gravel bigger than 50 mm. Inside the tank, filtration of the wastewater is performed through multiple layers consisting of mixed gravel at the bottom of the ring, followed by sand, rice husk and charcoal, sand and broken bricks before the effluent is discharged into the environment (Department of Water Supply, 2017).

In the sub-urban area, some households are also using pit latrines with single or double pits made out of concrete rings (See Figure 87. Rings used for septic tank with greywater pipe. These systems perform limited treatment and are more for containment of sludge with blackwater infiltrating into the environment through unsealed bottoms or through the sides of the rings.

Water in the Town – Story 10
Hotels and Guesthouses

Two popular examples of Sam Neua hotels are the Chittavanh and Phonchalern situated along the banks of the Nam Xam River in the centre of the town. Both hotels access the piped water supply system for bathing and cleaning. The hotels consume 130 m^3 and 480 m^3 of piped water respectively costing them approximately 1 million and 3.5 million LAK each. Both hotels have about 30 toilets as well as bathrooms for showering and hand washing basins. The toilets discharge into the hotels' septic tanks under the ground floor of the hotel or outside at the front of the hotel. It was explained by the owner of the Phonchalern Hotel that her business needed to have these septic tanks as per the government regulation as a hotel is a large building with many toilets and bathrooms. She explained that her septic tanks were sealed at the bottom and blackwater would overflow to the river. She further explained that she had never had to desludge the septic tanks while her neighbour at the Chittavanh Hotel added that he had had his septic tanks for ten years and desludged them twice a year. Unlike his neighbour, he reported that sometimes unpleasant odours emitted from the drain due to blockages. At both hotels, the greywater from bathrooms, the kitchen and restaurant is discharged to the drain and directly into the nearby river. (Interview with Business Owners, BORDA 2022)

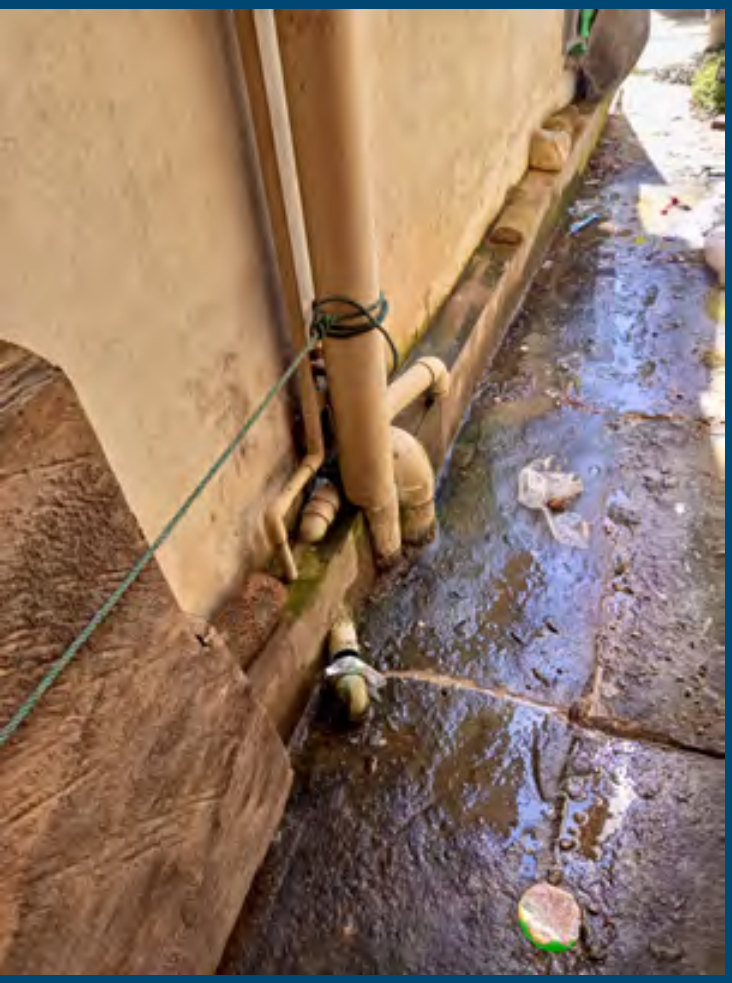
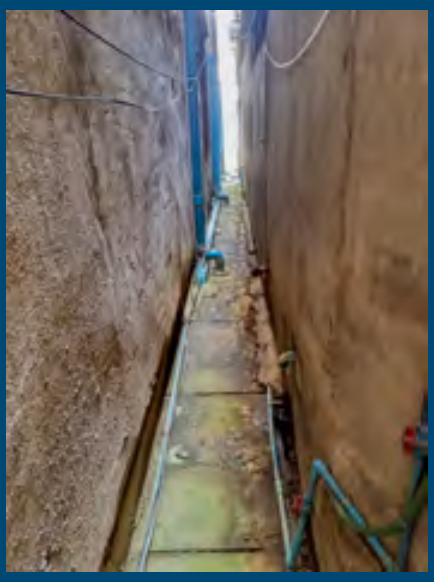


Figure 88. Wastewater Management at Hotels and Guesthouses

Source: (PUW Field Trip, 2022)



Examples of Treatment, Discharge, and Reuse (Including Sludge Management)

This section gives examples of the existing treatment, discharge and reuse systems including faecal sludge management.

Fecal Sludge Management Service Providers

The three desludging vehicles operating in the town can access all types of onsite sanitation systems and there are three different operators with one operator having the capacity to empty a 3 m^3 tank. The fees vary between 350,000 and 500,000 LAK per desludging. When needed, the septic tank owner can call the service provider to empty the septic tank. However, due to the steep slope at the dumping sites making access challenging, the trucks dispose of the sludge into rice fields, next to the national road or at the solid waste dump site (DHUP, 2020). Since faecal sludge is being disposed in open spaces without being treated, there is a need to improve and expand the wastewater treatment system and the collection efficiency.

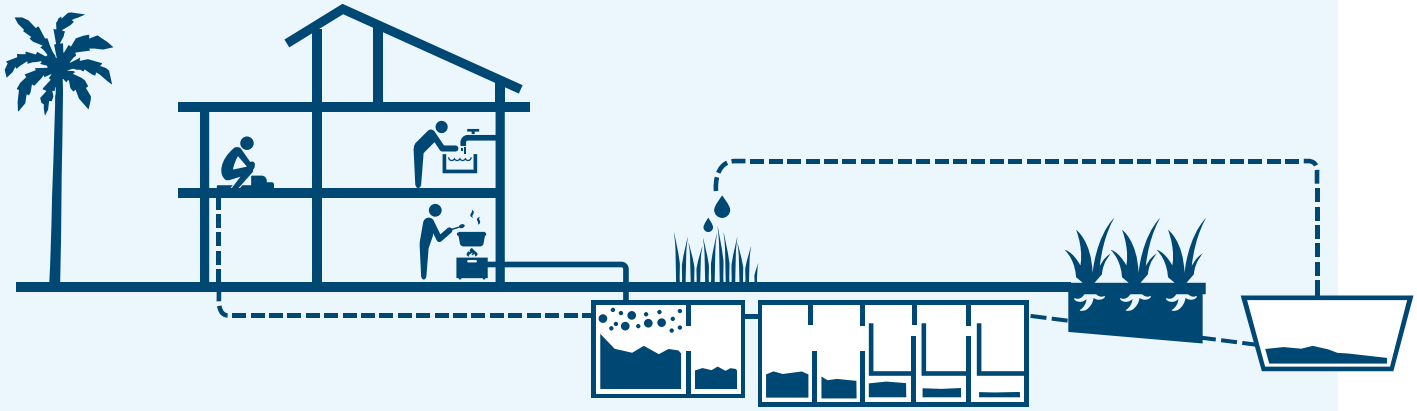
DEWATS (Decentralized Water Treatment Systems)

BORDA has installed two decentralized water treatment systems (DEWATS) to reduce the discharge of grey and blackwater into open spaces and the pollution of the environment, particularly given the forecasted increases in the population (BORDA, 2015).

Through a community action plan initiated in 2015 by BORDA, a DEWATS was built in Na Vieng village to serve 30 households. This DEWATS is a community-based sanitation project with the community owning and in charge of operating and maintaining it and the sanitation facilities within the village (Annex. DEWATS Management Roles). The Na Vieng village DEWATS covers about 30 households connected with secondary pipes to the system. A second DEWATS was installed at the Sam Neua. This system has a capacity of comparatively double the wastewater flow (BORDA, 2015). In the case of the Sam Neua DEWATS, the treated wastewater is discharged into the nearby open water bodies or into the local drainage channels. The water is not directly re-used.

DEWATS in Sam Neua

The DEWATS at the Sam Neua Market has a daily wastewater flow rate of 31.3 m^3/day and is made out of (A) a two-chamber settlement tank or septic tank, followed by (B) an anaerobic baffled reactor and anaerobic- filter, (C) a horizontal planted gravel filter, (D) polishing ponds or existing wetlands/lowlands/ponds, and (E) the re-use of treated water. The DEWATS has a treatment efficiency of 91 % for the chemical oxygen demand (COD) and of 93 % for the biological oxygen demand (BOD).



Source: (BORDA, 2017)

In Na Vieng Village, the DEWATS serves a neighbourhood of 30 households. The settlement tank reduces the water pollution by 25 %; the anaerobic baffled reactor reduces it by up to 75 % and the anaerobic filter reduces the pollution by up to 90 % (BORDA, 2015). The system has a capacity of 14 m^3 daily wastewater flow and consists of a two-chamber settlement tank (BOD removal of 28 %, COD removal of 26 %), followed by a baffled reactor with four tanks (BOD removal of 55 %, COD removal of 51%) and a final anaerobic filter with three chambers (BOD removal of 57 %, COD removal of 53 %). Before the implementation of the project, most households used toilets with septic tanks and soak pits. These were unsealed in the bottom and rarely emptied suggesting significant blackwater infiltration into the ground. Untreated blackwater from pit latrines and household greywater were discharged into the local drainage system and the environment contributing to pollution of local water sources. To counter this environmental pollution, the household sanitation facilities were improved and a shallow sewage system with a secondary pipeline constructed connecting household pit latrines and greywater to the DEWATS (BORDA, 2015) (See Annex. DEWATS Decentralized Water Treatment Systems).

Improper Waste Disposal and Wastewater

Sam Neua town and Sam Neua district face increasing challenges to manage adequately the household and toxic waste. With urban growth, the volumes are growing rapidly and the types of waste are differentiating. Organic and plastic waste is mixed with batteries, hospital waste, chemical residues, and other waste. For example, it is also easy to calculate the volumes of highly contaminated waste that the new 200-bed hospital will produce in the future. Much of the garbage is collected at the household level and a relevant proportion of recyclables, such as plastic bottles, are sent for recycling outside Sam Neua. Nevertheless, a significant proportion ends up in drainage systems, which can contribute to blockages and flooding. A much bigger problem, however, is the completely unsafe disposal of this waste at the dumpsite near Na Ang village.

A toxic mixture is increasingly forming there, posing a major risk to public health, water resources and ecosystems. As mentioned in the previous section on the state of urban water resources, the dumpsite may contain concentrations of heavy metals, such as iron, manganese, cadmium, chromium, copper, lead, nickel, zinc and mercury. Furthermore, significant amounts of the green house gas “methane” are produced.

The local government has recognized the urgent need for the construction of a sanitary landfill and is exploring options for an adequate site and urgently seeking adequate funding.

Figure 89. Open dumpsite in Sam Neua

Source: (PUW Field Trip, 2019)

Wastewater generated from car, truck and motorbike washing and internal combustion engine maintenance, such as from oils and lubricants, further contributes to the pollution of the surface water sources and potentially undermines water treatment. Used oil is hazardous to human and other mammals' health, potentially containing lead, benzene, zinc or magnesium, resulting in a range of health impacts after inhalation, ingestion or skin contact. For the wider environment, the oils, greases and lubricants can form an oil layer in polluted water bodies causing a reduction in light penetration and photosynthesis and reducing dissolved oxygen, severely impacting the survival of aquatic life (Jameel et al, 2011).

The poor management of bio-medical waste emanating from public health facilities and, in particular, the use of the septic tanks and the public drainage system to dispose of medical waste and fluids is highly undesirable. The use of these systems for waste disposal can contribute to polluting local ecosystems and water sources. For example, patients excrete their antibiotics and metabolites in their urine and faeces and these arrive in the hospital's sewage system. This is of particular relevance as 'hospital sewage contains two to ten times more antibiotic-resistant bacteria than domestic wastewater, a phenomenon which contributes to the emergence and propagation of pathogens, such as MRSA (methicillin-resistant Staphylococcus aureus) (IPCC, 2014).

Key Risks from Wastewater in Sam Neua

It has been noted that grey and blackwater is mostly discharged into the environment and the leaching of wastewater from dump sites pollutes the environment and the surrounding rice fields contributing to the pollution of local water sources.

For example, the sludge from detention ponds is disposed in low lying areas as backfill material (Department of Water Supply, 2018). Moreover, with increased construction of homes and other buildings, septic tanks and pit latrines are frequently installed close to groundwater and open water bodies intensifying the risk to public health. Furthermore, the households dispose of the greywater from their toilet and bathing areas to the micro or neighbourhood drain. The greywater from kitchens goes to the micro drain as well, and contains solid particles, such as food leftovers, raw vegetables, bones and plastic matter.

Figure 90. Household Domestic Wastewater Management
Source: (PUW Field Trip, 2022)

Observations during residential visits noted that as most houses are constructed on mountain and hill slopes or elevated areas, the greywater flows down into the nearby rivers while solid particles stay in the drain causing blockages contributing to localised flooding and further pollution of the environment combined with potential public health impacts. At the current time, Sam Neua does not have a slaughterhouse although one will be installed in the future, and will need to be planned for (Interview with UDAA, BORDA 2022).

Water in the Town – Story 11

Sam Neua Public Market

The public market is situated across the road and above the Nam Xam River in the centre of the town. It has a DEWATS installed by BORDA to manage some of the greywater from the wet market (wastewater from meat and fish stalls). However, in some cases the grease traps have been removed reducing the capacity of the system to adequately manage the wastewater. This DEWATS also manages the only toilets on site (the men's was blocked and only women's toilets were accessible to the public although the administration toilet was present but also locked). Large amounts of greywater come from hair salon businesses along the back wall of the market with the greywater running directly to the drain and mixing with the household greywater being discharged from the homes behind the market on the hillside. Wastewater flows through the site through open drains and into the river. Some of the drains were observed as being blocked by waste and trash (Interview with BORDA, 2022).

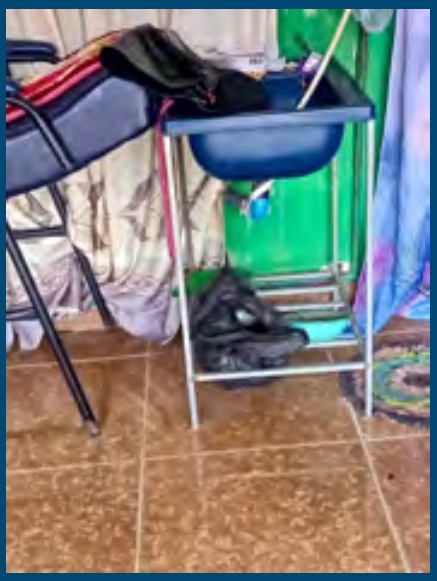
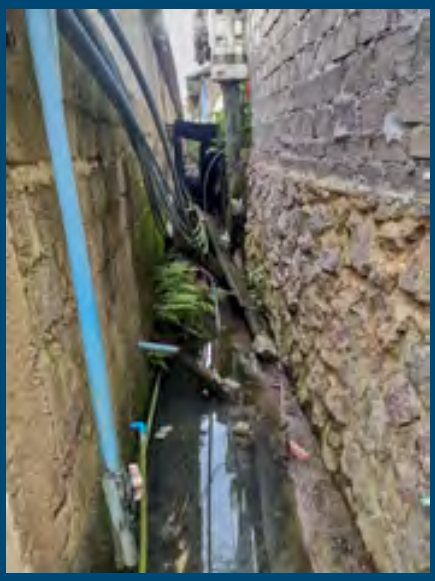
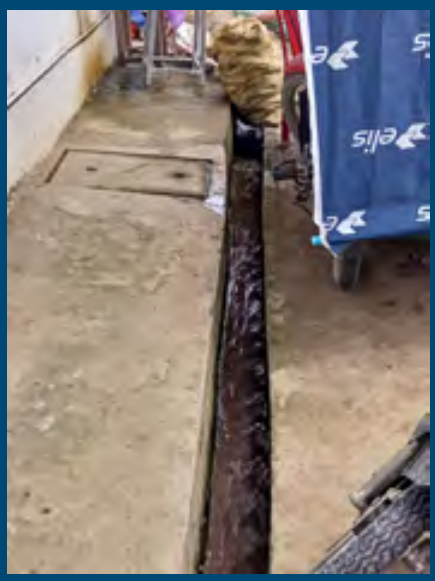


Figure 91. Wastewater Management at the Public Market

Source: (PUW Field Trip, 2022)





Mandate for Service Provision

Overall, legal responsibility for shared sanitation / sewage facilities is led by the MPWT, in support of the MoNRE, DPWT, and DoNRE. Arrangement of MoUs for water quality management is the responsibility of the MoNRE/MOIC and their provincial departments. Cost burden of the sewage facility is shouldered by the MPWT in coordination with MoF, and sewage tariffs are the responsibility of the DPWT in coordination with the NPNL. Establishment of the environmental protection tax is the responsibility of the MPWT supported by the MoF, MPI and the respective urban authority.

At the national level, as with water supply, the wastewater in urban areas is managed by the MPWT. The DHUP is responsible for urban water sector strategies and plans, technical standards and managing capital investments. Recently, the newly established Water Supply Department (WSD) has been made responsible for the water supply and sanitation and wastewater sectors. The Institute for Public Works and Transport (PTI) assists with technical knowledge in terms of studies, plans, and projects, etc. The Pollution Control Department (PCD) within the MONRE regulates, monitors and enforces laws and regulations to ensure the health of the environment, including wastewater pollution. The Department of Industry and Handicraft (DOIH) within the Ministry of Industry and Commerce (MOIC) regulates and approves the activities of large companies, including their industrial wastewater (ADB, 2020)

Operation and maintenace of community sewage treatment and septic tank cleaning and sludge removal is the responsibility of the Agriculture Department. Septic tanks and DEWATS are subject to technical standards with sub-national responsibility for implementation lying with the DPWT with support from the DoNRE (JICA, 2017). Ideally, septic tanks should be desludged more than once per two years with the cleaning of filters improving overall performance. However, in reality for household septic tanks, the owners and users have the responsibility for constructing, operating and maintaining their wastewater discharges and septic tanks. Community-based DEWATS users are represented by appointed members in a CBS Committee, these include the village head as acting chair, a senior party representative, deputy chairperson, finance and operation and maintenance (BORDA, 2015).

Generally, the local authorities emphasize decentralised wastewater treatment as their long-term management strategy. An urban sanitation development strategy for the timeframe of 2014-2030 focuses on the implementation of DEWATS in urban and peri-urban areas and in emerging towns through external funding sources (UNDP-SIWI Water Governance Facility, 2017).

While the DONRE has the responsibility for policy and strategy in terms of system objectives, this is reported as not functioning. Nevertheless, the DPWT is responsible for planning (micro-level functional requirements including septic tanks), macro-level functional requirements (SIPs), and municipal treatment plans. The DPWT and UDAA are responsible for asset management (system inventory, inspection of asset condition), and the DPWT is responsible for the assessment of asset performance. For the development of infrastructure, sewage treatment plants are the responsibility of the Agriculture Department. Supporting activities are implemented by the UDAA (promotion and public relations once a year) and the DONRE (controlling environmental pollution) (See Annex. Institutional Roles for Different Wastewater Treatment Tasks).

Water in the Town – Story 12

Hospitals

The provincial hospital is located along the banks of the Nam Xam River and in front of the much larger new provincial hospital building, which is under construction and could not be assessed at the time of writing. Both hospitals are located on land across the river from paddy fields that are gradually being converted to development land that continues to experience flooding. The provincial hospital has 134 staff with an 80-bed capacity. For comparison, the new hospital will have a 200-bed capacity and its own water treatment facility alghough specifications of this treatment plant are not readily accessible.

The hospital's patients access ten sets of toilets that discharge to eight septic tanks located in the hospitals garden and near the back wall away from the river. Medical waste from operations is also discharged to these septic tanks. However, one of the septic tanks at the back of the hospital away from the river is damaged and regularly fills with floodwater flowing down from the hill and road behind causing contamination of the ground and drainage system. This septic tank cannot be used during periods of flooding, and the drain is unsuitable to manage an overflowing septic tank. This septic system needs to be desludged two to three times a year as a result. The hospital regularly uses five to six million m^3 of piped water every month, and this can be as high as ten million m^3 per month depending on the season and the trend in diseases. The hospital's greywater is discharged into the ground and ultimately to the open drains and nearby river. The families of the patient's camp on the grounds of the hospital above the bank of the Nam Xam River where they sleep and cook while their family members are staying in the hospital (Interview with Provincial Hospital Director, BORDA 2022).

Figure 92. Wastewater Management at the Public Hospital

Source: (PUW Field Trip, 2022)

Figure 93. Wastewater Management at the Public Hospital

Source: (PUW Field Trip, 2022)

Practices in the District

The UDAA director is the district governor, and the UDAA is charged with performing operation and maintenance of infrastructures built by the DPWT. Its main responsibility is to keep the urban area clean, maintain town lights, collect solid waste, and manage the landfill. The UDAA has four divisions: administration and finance, urban management (solid waste collection and cleaning), implementation (monitoring) and technical. It has 20 officials and 14 labourers.

The DPWT plans and constructs the proposed infrastructures, and the UDAA operates and maintains the infrastructures built by the DPWT. The UDAA also grants construction permits for new buildings. New house owners must submit a land title and drawings certified by a design company to the UDAA for a construction permit. Once approved, the UDAA will visit the construction site three times to inspect compliance. Regulations for the construction management permit were published by the DHUP. It specifies elements that should be available, such as electricity, a water supply facility, and a wastewater treatment facility. However, the reality is that most houses are constructed without a permit, and these houses will be granted a property permit post-construction as an acknowlegement. A property permit only acknowledges that there is a building and does not confirm any structural integrity check.

For the building of septic tanks, it is necessary to acquire building construction permits from the DPWT, or they might not be granted, and this indicates that the DPWT promotes the use of septic tanks. According to local authorities, around 30 households per year ask for permission, and once granted, they are obliged to comply (Anecdotal evidence BORDA 2021).

Water in the Town – Story 13
Car and Motorbike Repair Shops

Car and Motorbike repair shops are scattered across the urban area. They provide services including oil changes, spare parts, accessories, and tyres. Repair shops for trucks are located outside of the urban area. One of these shops reported that they received 200 to 300 cars annually whiile a motorbike repair shop reported about 10 to 15 motorbikes daily coming for various services. Shop owners reported that used oil from cars, motorcycles, and trucks is collected and sold to oil collectors from Vietnam for about 40,000 LAK per container. The shop workers may also retain some oil for maintaining their own equipment, such as a water pump in one instance. The survey team was informed that the oil will be sold to chainsaw owners, carpenters, or to major collectors. At the end of the working day, the shop floor will be sprayed with water to clean and remove the oils and workers will wash their hands with the water flowing into the local drain (Interview with Business Owner, BORDA 2022).

Figure 94. Wastewater Management at Car and Motorbike Repair Shops.
Source: (PUW Field Trip, 2022)

Financing

In Laos PDR, construction costs for wastewater treatment units are paid through a combination of central government funds, loans, grants, aid and private enterprises (JICA, 2017). For example, the Global Green Growth Institute (GGGI) financed by the Korean International Cooperation Agency (KOICA) grant supports the development of decentralized wastewater and faecal sludge systems (Pakse Sanitation Project, BORDA 2021).

For finance, the DPWT and the UDAA are responsible for the investment planning while the DPWT are responsible for operation and maintenance budget preparation and execution. The UDAA is responsible for tariff setting and tariff collection, which includes solid waste and water supply service tariffs collected door-to-door with 10% paid to the collectors. There is no wastewater tariff, and there is no public expenditure on wastewater as this is currently managed individually by the private sector and households (See Annex. Sam Neua UDAA Budget and Expenditure). For funding operations, the UDAA organises its budget through the district government, which in turn requests approval as part of the provincial budget.

The analysis of the expenditure on solid waste management indicates only 0.2% of the total annual budget was allocated to the management of soild waste in 2021 down from 0.3% in 2017. The budget is small with the only revenue generated being the 12,000 LAK solid waste fee collected from households every month. Annually, the UDAA can collect 200 million LAK from the solid waste fee, yet the UDAA reported that the collection fee cannot cover all expenditure for the solid waste-related activities.

Currently, the UDAA's annual budget ceiling is 5 billion LAK, and the UDAA reported that the budget for the maintenance of the urban area is insufficient. With a ceiling of only 200 million annually from the government and implausible service cost recovery, UDAA can only perform surface cleaning.

For the community managed Na Vieng DEWATS, contribution fees of 5,000 LAK per household are collected to cover running costs. Thus, a saving of 55,000 LAK per month funds small-scale repairs, desludging and materials. Financial records are kept and reported monthly, which enables monitoring as well as external audits. Consequently, financial training is provided and additional safeguards against misuse are in place (BORDA, 2015; PUW, 2019). DEWATS projects in emerging towns and in urban and peri-urban areas are mostly financed externally, for example by NGOs such as BORDA (JICA, 2017).

Water in the Town – Story 14
Silk Weaving and Dying

Silk production is one example of a potentially polluting small scale household handicraft production due to the silk dyeing process. Nearly 80% of the households living in the area of Phoung Village were dyeing silk before the Covid-19 pandemic reduced customer demand. Many complaints about the yellow-coloured pollution of the Nam Xam River were filed with the provincial government in the past year. The government officials reported that this was due to the dyeing or colouring process in the silk production area.

This has been improved with an intervention from the Ministry of Health to install a combination of sand screen and soak pits [observed by the field visit team]. Wastewater that contains colouring agents is collected in a bucket and then poured into a sand chamber for screening before infiltration into the ground. The mix of chemicals used in dyeing and finishing the silk contains numerous pollutants, mostly heavy metals like lead (Pb), chromium (Cr), cadmium (Cd), copper (Cu), and nickel (Ni). Among the heavy metals, the discharge of untreated water causes water pollution by increasing biochemical oxygen demand (BOD), chemical oxygen demand (COD) and a higher concentration of total dissolved solids (TDS), chloride and sulphate. Additionally, the process of photosynthesis seriously affects the level of dissolved oxygen (DO), which is reduced due to the presence of the dye coloring in discharged water impacting the transparency and aeration of the water surface (Hussain et al., 2020).

Interventions to 'treat' wastewater from dyeing processes are insufficient to a large extent. The survey team observed that some wastewater from the dyeing process is discharged directly into the drain and then into the streams. The business owners seem to have little knowledge of the dangers of disposing of dying agents into the streams or methods to mitigate or prevent this. It was observed that children were playing in the river downstream from where the village's drainage channels were discharging into the same river. (Interview with Business Owner, BORDA 2022)

Figure 95. Photographs from top-left to right: Dyed silk drying, adding water to the dying pot, drainage channels. Photographs from bottom-left to right: Toxic checmical fixant and dyes, field team member sitting on edge of soak pit, local wastewater drainage.

Source: (PUW Field Trip, 2022)

Policy and Legislative Frameworks

Despite some departments and ministries being responsible for both water supply and wastewater and sanitation management, the policy framework for wastewater is still not clearly defined. Although Urban Development Administration Authorities (UDAA) are responsible for the management of sewage, wastewater, solid waste and drainage systems, they often lack capacities and resources to implement their mandate.

Additionally, there are gaps in legal frameworks and regulations. For instance, in 2009, the Water Supply Law entered into force without an accompanying law for the sanitation sector, so there is no single law that regulates the sanitation sector in Laos PDR, and there is no specific standard for wastewater discharge (ADB, 2021). Therefore, a range of current national legal regulations cover sanitation and pollution and have to be considered (Djondo, 2020):

- Decree on Environment Impact Assessment 2018
- Law on Construction 2008
- Law on Environmental Protection 2012 – Article 35 Pollution Control Measures (revised); Article 41 Environmental Certification (new); Article 42 Permission on Pollution Emission (new); Article 43 Environmental Compliance Certificate and Pollution Permit(new)
- Law on Hygiene, Disease Prevention and Health Promotion 2001
- Law on Industry Processing 2013;
- Law on Urban Planning 2017
- Law on Water and Water Resource 2017 – Article 30 Water Quality Standards and Wastewater Discharge Standards (Revised) & Article 31 Wastewater Discharge Permission (New)
- National Environmental Standard 2017;
- Standards on Discharge of Water Pollution from Toilets and Wastewater from Industrial Factories, 2005, No.326/IH No.326/IH Laos
- Regulation on Monitoring and Control of Waste Discharge 1998

More specifically, the Prime Minister (PM) Decree No. 37 on the Management and Development of Water Supply and Wastewater Sector identifies the MPWT, MoH and the office of Natural Resources and Environment at the district and municipal level as sharing responsibility for sanitation. Furthermore, an Infrastructure Sector Working Group allows for governmental institutions, international partners, and the private sector to discuss and address issues related to water, sanitation, and urban development. The National Pollution Control Strategy and Action Plan 2018-2025 identifies wastewater and sanitation causes of water pollution and outlines strategies for managing water pollution in urban areas. A Decree on Fees and Service Charges includes fees for wastewater treatment but does not specify the required sewer connections or the transportation of wastewater, and no institution has the mandate for the collection of sanitation revenues. To implement sanitation measures that align with the NSDEP, the finance is allocated in the annual state budget developed by the MoF in consultation with the other state institutions. This state budget is financed through domestic revenue collection and international partner development assistance (Djondo, 2020).

The Politburo Resolution No. 3 includes the Sam Sang policy and defines development targets for the central, provincial and district levels. The Sam Sang policy focuses on political and administrative decentralization and development and was revised in 2012 to support the capacities of villages' infrastructural and social development. Village clusters are referred to as emerging cities (UNDP-SIWI Water Governance Facility, 2017).

Water in the Town – Story 15
Residences

This male interviewee lives in Sam Neua Village on the slope above the Nam Xam River. He lives there with his wife. His house is quite large and has been converted from a wooden house. They use the piped water supply for washing and showering at a cost of 120,000 LAK per month, and they use three 20-litre blue bottles per week for drinking and cooking at a cost of 6,000 LAK per bottle delivered directly to their door in exchange for the empty blue bottle. Their toilet discharges to a three-chamber septic tank with greywater discharged directly to the open drain running down the slope past the houses towards the river. The septic tank is 3m by 1.5m and about 3m deep. It is situated under the bathroom at the rear of the house, and if it needs to be desludged, the owner must break the side wall of the tank so that the pipe to suck out the sludge can be inserted. However, he reports that in 20 years, he has never had to desludge the tank indicating that potentially the tank is not adequately sealed. He also collects rainwater, which he directs into large plastic containers. He explains that he uses the rainwater to clean out these containers as he uses them for his small business fermenting vegetables that are then sold at the market by his wife. At the river running past the village below his house, a presence-absence E-coli test was performed confirming the presence of E-coli in the river water (Interview with Home Owner, BORDA 2022).

Figure 96. Male Interviewee's Home and Wastewater Management

Source: (PUW Field Trip, 2022)

Stormwater Management and Drainage Systems

Key Messages of Section

Effective **stormwater management** will be a **key element** for strengthening the **resilience** of Sam Neua against **natural disasters**. Yet there is **neither the infrastructure** nor the **management scheme** in place to respond to this challenge.

The town is faced with an **increased storm-water run-off**. The reduction of the water absorption capacity of the soils reduces water retention, accelerates the water run-off and contributes to the i**ncreased flood vulnerabil-ity** of Sam Neua and its peri-urban transition zones, especially during heavy rainfall events.

The extension of **grey drainage systems alone will not be sufficient** to manage the expected quantities to be drained. Sam Neua town still has **plenty of opportunities to develop integrated approaches to combine grey and green/blue infrastructure for effective stormwater management**.

Stormwater and roadside drainage as well as **micro-drains are common** across the town and **are a good basis for further exten-sion.** However, on the whole they are **poorly designed and managed**.

All **forms of drainage** can be found in the town, whether for stormwater or other purposes, and can contain household greywater, kitchen waste, and even industrial and agricultural waste from small-scale businesses, such as silk dyeing and car and motorbike maintenance.

Solid waste blocking the drainage network seriously impacts the drainage networks effi-ciency. This is one example of when intersec-torial cooperation –waste management and drainage development – is needed.

The extension and further development of grey drainage systems alone will hardly have the capacity to cope with the expected stormwater run-off. The **development of water retention basins, structures for rainwater harvesting and the maintenance and development of water infilitration areas** are crucial parts for **an integrated stormwater management strategy.** Again, intersectorial cooperation and planing is needed.

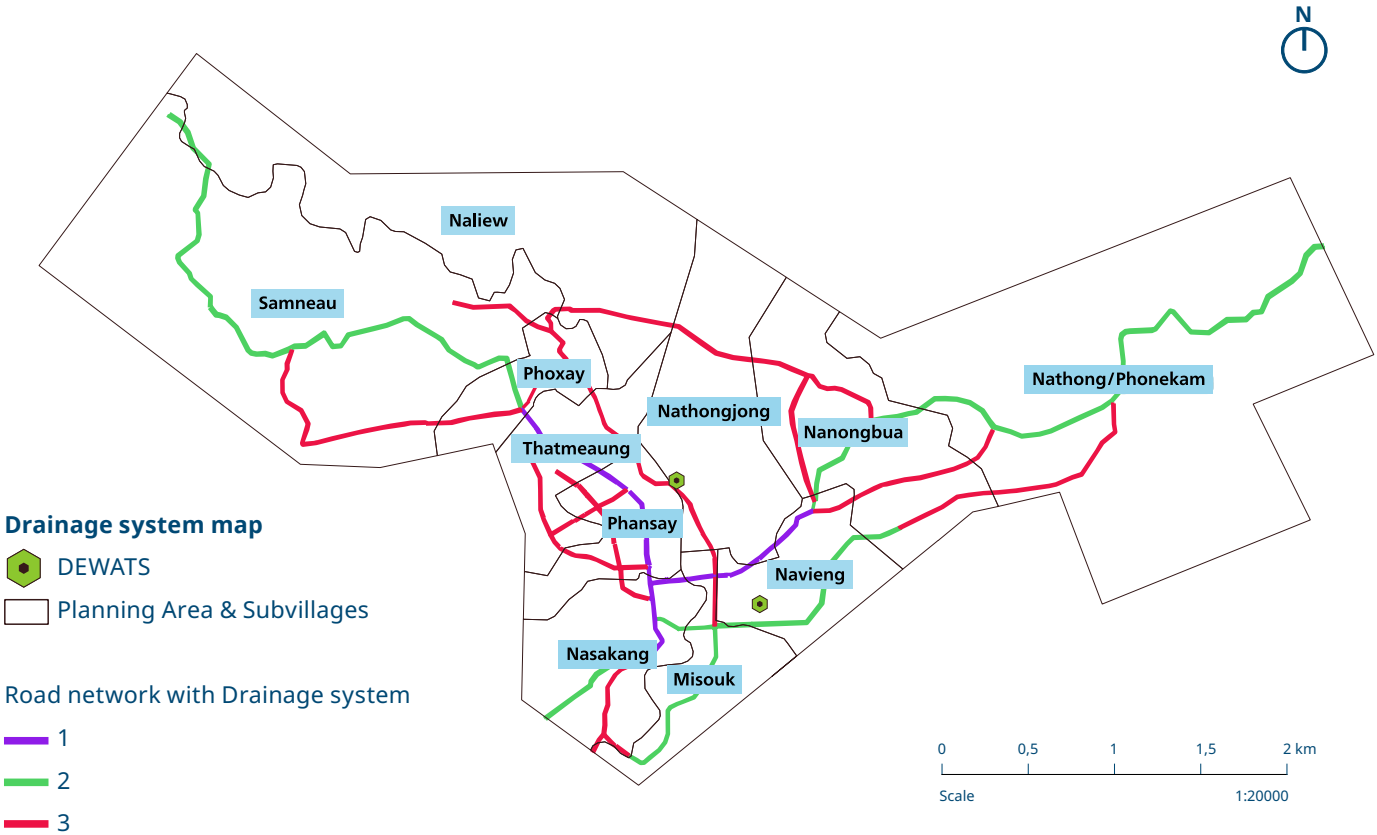
The development of the drainage system is an example of Sam Neua's need for **proactive infrastructure development** as part of **effec-tive urban planning**. If infrastructure develop-ment follows the current construction practices in the Extension Areas, it is difficult to develop effective drainage systems.

Stormwater Drainage Coverage

In total, Sam Neua has a roadside drainage system 30.5 km long and an open channel of 19.3 km long. The following map presents the drainage channels dependent on the different road types. Stormwater consists of rainfall-runoff and any dissolved or non-dissolved material that is mixed with the flow. The drainage system in Sam Neua is either a closed or open channel next to the road and is used for discharging wastewater untreated into the environment (See Figure 96).

Figure 97. Drainage system according to the Road Network.

Source: Based on the Urban Plan of 2011 (Data replicated from MPWT (2010)



Greywater and Stormwater Drainage is Discharged from Houses and Roads into River Tributaries

Figure 98. Household and Road Drainage to River

Source: (PUW Field Trip, 2022)

Key Trends of Stormwater Drainage in Sam Neua

Sam Neua's urban development has followed conventional approaches as defined by the replacement of much of the vegetated areas with impervious surfaces. This results in less rainfall infiltrating into the soil, less water to replenish the local groundwater aquifers, and an increased volume and speed of stormwater run-off leading to a greater risk of flooding the urban area.

Today, infiltration areas are distributed throughout the town in the form of gardens, rice fields, and green spaces, etc. With increasing construction activity, a rapid sealing of the urban space and the extension areas can be observed. It is common practice to seal almost the entire area of new buildings, not only for the construction of the actual building, but also for all parking spaces and other usable areas around the property.

There are some green areas situated in Sam Neua alongside the riverbanks and in the town centre that serve as infiltration areas: one is near the football stadium called the 'Houaphan-Quang Ning' Park and has unpaved surfaces through which water can infiltrate, and another is the 'Houaphan-Than Hoa' Park with concrete paving that allows some infiltration through the gaps between the paving slabs. In some areas in the outskirts of Sam Neua, fishponds are close to the river network. These can collect rainwater but are also a source of flooding during intense rainfall events.

It is clear that the dynamic urbanisation process entails a high degree of land sealing. Together with land use changes in the watershed, land consumption leads to increased flood vulnerability, which can only be mitigated to a limited extent by maintaining green spaces.

Considering existing and potential future drainage networks, extreme rainfall during the wet season may cause stormwater to drain directly into the natural ponds, streams and rivers increasing the risk of infectious diseases (Schmidt et al., 2016). Moreover, poor solid waste management causes drainage channels to be blocked by food scraps and garbage with heavy rain causing regular flash flooding of Sam Neua town. Nevertheless, within this context of increased intense rainfall associated with climate change and the current urban development trends (loss of infiltration areas and limited rainwater storage), the town's management of stormwater is insufficient. Furthermore, with no urban Master Plan available, it is not possible to estimate the future impact of stormwater on the town although it is understood that expansion of the drainage network will likely accompany the expansion of the road network contributing to similar risks as experienced currently.

Figure 99. Examples of existing infiltration areas in Sam Neua town

Source: (PUW, 2019)

Water in the Town – Story 16

Flooding Vulnerability Affects Local Tourism Businesses

The area along the river where many hotels are located has experienced flooding in the past. The owner of the Chittavanh Hotel explained that the flood of 2007 was very high with more than one metre of floodwater above the river flooding the ground floor of his hotel to a height of 20 cm costing 45 million LAK to repair and clean everything. At other times flooding only reaches 20 cm above the river level and does not flood the ground floor. If there is extreme flooding, he explained that the hotel's septic tanks are flooded through the overflow pipe and have to be desludged. In 2003, he explained that despite flooding of the nearby paddy fields for one night, there was no flooding of the town. He understood that there was now heavier rain, yet he did not immediately recognise that the filling and covering of the paddy fields was increasing his business' vulnerability to flooding. At the current time, he employs three staff and welcomes about 300 guests per month, and if Sam Neua becomes more popular with tourists and visitors in the future, he will expand his business by building additional floors on his hotel (Interview with Business Owner, BORDA 2022).

Mandate for Service Provision

The mandate for the existing stormwater drainage in Sam Neua is shared between the DPWT (maintenance) and UDAA (construction) according to the form of construction (Anecdotal evidence, BORDA 2021).

Key Roles and Responsibilities

Drainage networks come under the mandate of the MPWT to operate and maintain. The provincial departments at the DPWT are assigned the duty to plan and maintain the existing road networks, including the drainage network (MPWT, 2018). The DPWT and the UDAA have the same key roles and responsibilities for stormwater drainage as they do for other wastewater infrastructure (See Wastewater Management: Mandate for Service Provision above & Annex. Institutional Roles for Different Drainage and Sewerage Tasks)

Moreover, due to solid waste blocking the existing stormwater drainage, the community participates in regular cleaning events twice a month, known as "Red Saturday". In the case of flooding, the local government provides sand bags to its residents as a form of flood prevention (BORDA, 2021).

Financing

The analysis of the expenditure on drainage shows that the district administration only allocated 0.05 % of the total annual budget for O&M of the urban area in 2017 and only 0.02 % in 2021.

Policy and Legislative Framework

This mandate and assignation of duties references the following political frameworks (MPWT, 2018):

- Prime Minister's Decree on the Organization and Operation of the Ministry of Public Works and Transportation No.295/Prime Minister, dated 04/09/2017
- Proposal of the Department of Organization and Personnel No.415/MPWT. DOP dated 04/07/2018 Agreement of the Party Standing Committee of the Ministry dated 03/08/2018

F.

Urban Planning

Key Messages of Section

New changes to the urban planning legal framework in Lao PDR aim: **to promote investment** in urban development in order; **to "turn land into capital"** emphasizing mechanisms to attract FDI; and **to improve coordination** between implementing ministries and departments.

SDGs and sustainable development principles: There are legal, regulatory and policy foundations to plan the town according to **sustainable development principles, including SDGs which are integrated in the District SEDP.** For undeveloped urban extension areas, there is a **very important opportunity** to undertake appropriate urban planning processes to create integrated urban plans that follow sustainable, safe and resilient development principles and SDGs

A multitude of roles and responsibilities in urban planning overlap and various important planning processes take place outside the town. There are many roles and responsibilities concerning urban planning that are spread across various central departments and ministries with overlapping responsibilities. As such there is a need for a clearer definition, and co-ordination of roles and responsibilities at different levels.

A multi-sectoral and multi-stakeholder process is promoted *(1 City 1 Plan).*
The urban planning system formally requires a range of political actors, including multiple key sectors, village leaders and administrators, community groups, at various stages of creating plans for the town. However, many key actors are only formally consulted in two development process meetings, rather than fuller participation in local decision-making processes.

There remains at present, prior to further developments in Sam Neua, a vitally important **opportunity to engage the key investment stakeholders**, particularly in real estate and property development, in the planning and development process of Sam Neua

The current Master Plan process requires **a very long timeframe to complete** through official approval / permissions required at each step, which may render it less up-to-date with the development needs and realities of the town.

Planning is **practiced reactively rather than pro-actively** having to redress spatial designs and regulatory frameworks as urban development progresses forward.

Planning and building controls only apply to developments that have sought a building permit. It appears there are **developments that avoid the permit/ building approval process** and are, therefore, not subject to building approvals and controls.

The urban planning process contains requirements that are **beyond the capacities of local planning departments** in terms of human resources, budget resources and enforcement.

There are new national policies and strategies focused on climate change adaptation and sustainable development, yet it appears awareness and their **integration into urban planning processes is limited at the local level.**

National standards for building codes to address **risks posed by climate change are still being written**; there is a **greater need for local integration of policies on climate change adaptation and sustainable development.**

Public awareness about planning is limited and it appears there are residents who are not aware of permits and the building approval process and are therefore building in unsafe locations and following risky practices.

Mandate

Sam Neua is classified under current Lao PDR town classification system as a Level 2 town for which there is a specific urban planning process administered by a chain of government actors through a centralised framework. The key mandates for creating the town's master plan are as follows: the Governor of the Province initiates the master plan process; the budget is provided by the MPWT (DHUP); the Master Plan is prepared by the PWTI and DPWT of Sam Neua and approved by the Minister of the MPWT.

The role of agencies in relation to urban master plans

Who initiates the process			Who provides the budget			Who prepares the plan			Who approves the plan		
Level 1	Level 2	Level 3	Level 1	Level 2	Level 3	Level 1	Level 2	Level 3	Level 1	Level 2	Level 3
Governor of the Province		Head of District	MPWT (DHUP)	MPWT (DHUP)	DPWT	PTI & DPWT, and private planning agencies including internal and external consultants			Prime Minister	Minister of MPWT	Governor of the Province

Figure 100. The role of agencies in relation to urban plans.

Source: replicated from (PWRTI 2011)

In general, the MPWT is the primary office responsible for urban planning at national and provincial levels. The two key departments of the MPWT involved are the DHUP and PWTI. The Departments and Offices of the MPWT at the provincial and district levels liaise closely with the local administration, the Provincial Governor, Heads of District, Nai Bans, VUDAA/UDAA and with the Heritage Office (Ministry of Public Works and Transport, 2011). **(See Annex: Key stakeholders in national and local urban planning processes; See Annex. Provincial Level Roles and Responsibilities of Sector of Housing-Urban Planning and Water Supply (SHUP)).**

Multi-sectoral Cooperation

Effective collaboration between the sectors is a national level mechanism for project coordination in Lao PDR. As such, in Sam Neua town muti-sectoral collaboration is undertaken as part of the formal process for urban planning and development. This means that **all departments from provincial and district levels are required to be involved in major town projects**, regardless of which department is heading the project. Accordingly, other secrors are involved in key water related DPWT projects. For the most part, collaboration takes place in the form of focused project meetings throughout the project cycle, reporting, open discussions and “problem shooting” between technical staff and executives, which is effective as in a smaller town, local departmental staff are very familiar with each other and each other’s needs. According to local staff, safe storage for collecting and storage of data is urgently required, and improvements in multi-sectoral collaborative tasks would be improved with data sharing technology, such as a dedicated, separate storage server (2022, PUW Interview with DPWT).

Local Budget for Urban Development

While the budget for the entire urban planning process is provided by the MPWT (DHUP) (as indicated above), core funding for implementation of the proposed developments approved in the District's 5-year Social Economic Development Plan is received directly from national and provincial funding mechanisms. Local revenues earned by local taxes, such as property tax, are passed to the national government, which empowers the province to distribute them via their annual budgets. Additional funding may be available from approved ODA loans and grants from friendship countries (see below for Sam Neua).

An observation by the CDE (2018), is relevant in that "The governance of urban areas is a challenge for an administrative system that knows no dedicated administrative entity for towns and cities, lacks the relevant capacities, and where the lack of cross-sectoral coordination processes and mechanisms allows sectoral laws and interests to compete in a way that **"let the faster and economically stronger succeed in creating new realities in urban developments on a nearly daily basis**." (CDE, 2018, p.31)

Urban Planning Approach

The urban planning process in Sam Neua is described in the nationally relevant **Urban Planning Manual**, which provides the key process and steps, which urban areas must follow in their respective urban planning processes. For completing each step, an official letter of confirmation from the provincial level is required to continue, as such creating and approving the plan can become a very long process (**See Annex. Administrative structure for urban planning in Laos, Sam Neua**).

As in other cities in Lao PDR, Sam Neua applies a linear master planning approach driven technically at the central level by the PTRI and DPWT (under the MPWT) with participatory stages and consultation requirements with line agencies. Each urban area is provided with an Urban Master Plan, valid for a period between five and fifteen years, as a key instrument to guide development, protect the town and its population and be consistent with the growth expectations and priorities of the socio-economic development plan. It defines land uses, construction projects, renovation projects, and expansion activities and contains regulations. An Urban Master Plan sets out land uses for public infrastructure, which should align with the national socio-economic development priorities. The Plan follows the stages of: identification of a scope for a plan; research and data analysis with a strong emphasis on consultations (with line agencies, relevant sectors, and key prescribed local actors and community groups); reviewing; and final submission to local authorities for implementation. Regular monitoring and evaluation activities are not necessarily performed. Ultimately, an Urban Master Plan has three key components: a report, regulations, and maps and plans as illustrated below (Ministry of Public Works and Transport, 2010). (See Annex. Steps and methodology for preparing urban plans in Laos)

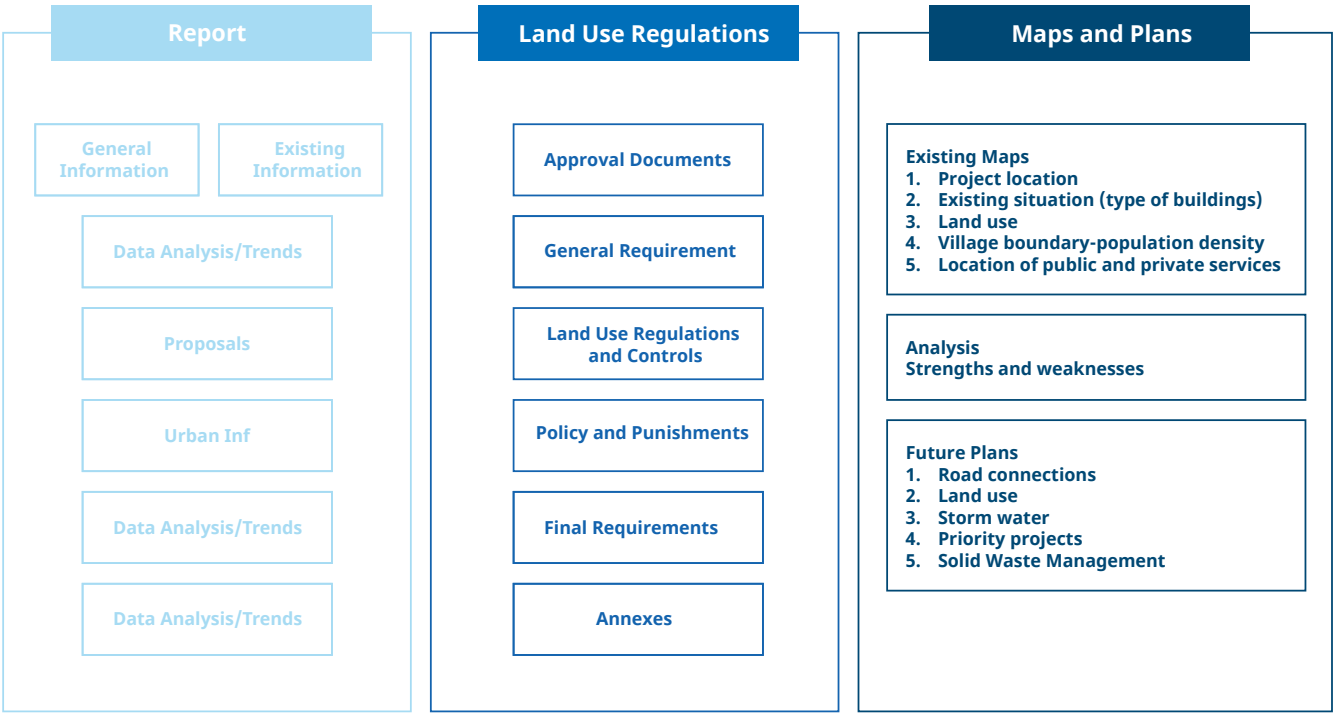


Figure 101. Components and process of the Urban Master Plan

Source: (Ministry of Public Works and Transport, 2010, p. 15)

Implementation of Sam Neua's Urban Master Plan

According to a 2008 survey, the 1996 Urban Plan experienced **limited implementation** due to difficulties experienced with the dedicated "green areas" for development (MPWT, 2010). It appears that this area was less accessible as uncleared land / forest, which most likely added additional costs to construction making it less attractive compared to alternatives. Additionally, **the location away from the existing built-up areas may have influenced development patterns**. Instead of following the Plan, **development and growth took place along the main roads and streams**, which may have been better suited, more accessible and/ or more likely approved for the types of construction taking place, and lack of controls and monitoring (Ministry of Public Works and Transport, 2011). It was possibly also a question of location and/or proximity to the central, more established area. The following 2011 Urban Master Plan attempted to redress the loss of adherence to the 1996 Urban Master Plan and readjusted urban development to return and continue with the intentions of the 1996 Plan. This included land clearance of the green areas designated as areas for new development and urban expansion.

Socio-Economic Development Plans – National Level and Sam Neua District

In addition to Urban Master Plans, provinces, districts, are required to prepare **5-year socio-economic development plans corresponding to the 5-year National Socio-Economic Development Plan** (as mentioned in Part A of this study). The general objectives of these plans are: 1) Overview of geography and socio-economic situation; 2) Identification of development needs and potentials; 3) Strategic plan for the development and management of the area; 4) Implementation of budget objectives for the five-years (Ministry of Public Works and Transport, 2011).

The goals of the 9th NSEDP (2021-25) are to achieve sustainable, balanced and quality growth of the nation's economy; improve the standard of human resources, research capacity and the use of technology and science, in order to boost productivity and produce more value-added goods; improve living standards; **create more green spaces and pursue environmentally friendly development**; promote strong and modern internal, regional and international cooperation, and **increase the effectiveness of public administration** through the rule of law and public unity. The 9th NSEDP will guide policymaking to advance sustainable and inclusive growth, human capital investment, infrastructure development and progress towards the smooth transition from Least Developed Country status. (UN Lao PDR, December 2020).

From this document Sam Neua District derives its own 5-Year Socio-Economic Development Plan as follows:

Sam Neua District 5-Year SEDP contains non-detailed plans, usually in the form of general sectoral targets and budget information. The stated vision of the previous 5-year Plan is: Development of Sam Neua district into a center of trade, services, culture and tourism-related goods production and sustainably protect the environment. According to the plan, the main potentials for socio–economic development include: 1) Agriculture and livestock; 2) Weaving crafts – weaving silk fabrics; 3) Electric Power; 4) Trade – Services; 5) Nature-based Tourism and Culture.

Priority projects in the district SEDP can take up to 4 years to be designed and approved after passing through provincial and national administrative channels. For the Provincial Parliament an important criterion in its decision-making process is the level to which projects meet the needs of citizens (Hodgson, 2019).

Other development plans of significance for Sam Neua town include:

- **Urban Development Strategy 2030** rationales include the **urbanization of rural areas through the development of small towns** towards reducing rural-urban disparities, as well as **strengthened regional integration** through the development of economic centers along main transport corridors.
- **The Sam Sang ("Three Builds") directive (Politburo Resolution No.03/CPP/2012):** Launched in 2012, in terms of urban planning, Sam Sang acts as a driver, **defining the partition of tasks, duties and responsibilities from the center to the local level for the different levels of towns** defined in the Law on Local Administration.
- **Land titling program to provide poorer populations with secure tenure** Certain areas of the Lao PDR have witnessed emerging land markets and rising land prices. This potentially prohibits poorer populations from either retaining or gaining access to land. A potential consequence sees growing numbers of informal urban settlements without adequate services.

Sub-local Roles and Responsibilities and Community Engagement

At the village level in Sam Neua, (12 villages) the Village Chief (Nai Ban) and deputies are involved in the planning process and support the DPWT and PWTI survey teams in the Urban Master Plan preparation process. Their core functions are to collect data at the village level and, as representatives of their village, comment on the draft plan at consultation meetings, as well as assist DPWT to implement the approved urban plan. Additionally, they should feed relevant information into the District´s 5-year Plan and Village Land-use Plan. In Sam Neua town, village Land Use Plans were last produced in 2011.

At the village level, for the district level planning process, consultation and comment by the public and other concerned agencies is required, such as representatives of relevant provincial and district departments, Village Chief, and representatives of organizations, including the Lao Women's Union and Lao Youth Organization. Private citizens are also allowed to attend the consultation sessions. The Village Chief and deputies have a role in ensuring implementation of plans (PWRTI 2011).

Multi-Stakeholder Involvement and Public Participation

For producing the Urban Master Plan, the planning process (prescribed in the Urban Planning Manual) requires relevant stakeholders (below) to participate in at least two consultation meetings (these meetings are explicitly not decision-making activities) to be given the opportunity to comment on a draft urban plan. Collection of data is also an important activity carried out by different stakeholders, which requires verification by the DPWT and Provincial levels. Stakeholders include the local administrations, the relevant sectors (Agriculture and Forestry, Industry and Commerce, Energy and Mining, Education, Health, Information and Culture, Land Management, and the provincial offices of Water Resources and Environment) (line agencies), the mass organizations (The Lao Front, the Lao Women's Union, the Lao Youth Union and Lao Trades Union), the private sector and the public as shown below, which applies to Sam Neua as a Level 2 town.

Actors	Level 1	Level 2	Level 3
MPWT	X	X	
DPWT	X	X	X
OPWT	X	X	X
Provincial Administration	X	X	X
District Administration	X	X	X
Nal Bans from each village	X	X	X
Relevant Sectors	X	X	X
Mass Organisations	X	X	X
Planning Agency (e.g. PII)	X	X	X
Local Chamber of Commerce (private sector)	X	X	X

Figure 102. Participants required for urban planning consultation meetings

Source: (PWRTI 2011)

Legislative and Policy Framework

Principal Laws and Ministerial Orders

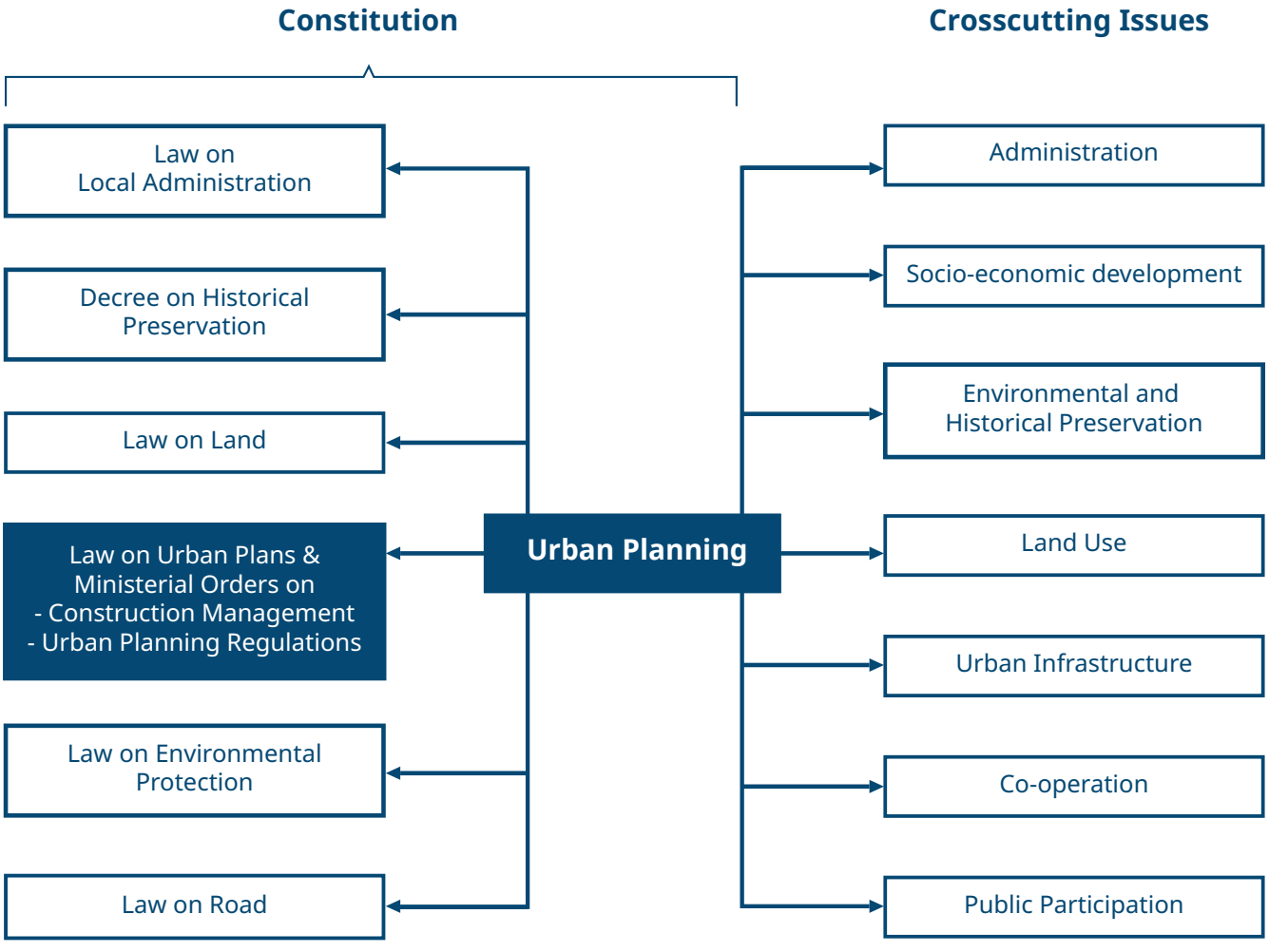
The laws and cross-cutting issues related to urban planning in Laos are summarised in Figure 77 below. Principal Laws and Ministerial Orders relating to urban planning include: the Law on Urban Planning (No. 03-99/NA, 1999, revised in 2017), which essentially aims for a clearer policy on the promotion of urban development, promoting **investment roles** for Development, the private sector, public-private partnerships and FDI. In general, legal revisions aim to **improve coordination** between implementing ministries and departments. Of particular significance is a harmonization with investment policy, **emphasizing mechanisms to attract FDI.** For example, the new Land Law potentially provides new articles stipulating land leases for **foreign investors, SEZs (Special Economic Zones), and high-rise buildings,** thereby aligning with the government strategy of ***'Turning Land into Capital' (TLIC).***

Planning Regulations and Building Codes for Urban Planning Zones

Of importance for the context of Sam Neua's urban development area are the building codes for each of the planning zones, as well as the regulations for construction management, environmental protection, and preservation of cultural and natural heritage, among others. It is important to note that such urban planning regulations and building codes for respective zones offer a very good opportunity (entry point) for new water-sensitive planning and development measures (e.g. new regulations, design guidelines, standards, etc.) that could be officially adopted and implemented in the town.

Figure 103. Laws and cross-cutting issues related to urban planning in Laos

Source: (Ministry of Public Works and Transport, 2010, p.4)



References

[UNDRR] United Nations Office for Disaster Risk Reduction. (2020). Hazard Definition & Classification Review: Technical report.

A. DeBarry. (2004). Watersheds: Processes, Assessment, and Management. John Wiley & Sons, Inc.

ADB. (2009). IEE: Regional: Second Northern Greater Mekong Subregion Transport Network Improvement Project (as of Board approval).

ADB. (2012). Lao People's Democratic Republic: urban development sector assessment, strategy, and road map. Asian Development Bank.

ADB. (2018). Initial Environmental Examination LAO: Additional Financing of Water Supply and Sanitation Sector Project (Xamneua Subproject).

ADB. (2020). Completion Report Lao People's Democratic Republic: Small Towns Water Supply and Sanitation Sector Project.

ADB. (2021). Wastewater Treatment Solutions for Urban and Peri-Urban Communities in the Lao People's Democratic Republic, ADB, Manila. ADB.

Bai, X. (2018). Advance the ecosystem approach in cities. In Nature, 559, 7–7.

Beck, H. E., Zimmermann, N. E., McVicar, T. R., Vergopolan, N., Berg, A., & Wood, E. F. (2018). Present and future köppen-geiger climate classification maps at 1-km resolution. Scientific Data, 5. https://doi.org/10.1038/sdata.2018.214

BORDA. (2015). Community Action Report for community based sanitation Navieng village XamNeua District Huaphan province Lao PDR.

BORDA. (2021). Personal Communication.

BORDA. (2022a). Interview with Business Owner.

BORDA. (2022b). Interview with School Director.

BORDA. (2022c). Personal Communication with Homeowners.

BORDA. (2022d). Personal Communication with farming family in Phoung Village.

Boyd, C. E. (2011). Aquaculture Effluents and Water Pollution Resource use View project Effects of Aeration on Evaporation Rate and Water Temperature View project. https://www.researchgate.net/publication/267877126

CDE. (2018). Urbanization processes in the Lao PDR Processes, challenges and opportunities.

CFE-DM. (2021). LAO PDR Disaster Management Reference Handbook. https://www.cfe-dmha.org

Christensen, J. H., Hewitson, B., Busuioc, A., Fu, C., Christensen, J. H., Hewitson, B., Busuioc, A., Chen, A., Gao, X., Held, I., Jones, R., Kolli, R. K., Kwon, W.-T., Laprise, R., Rueda, V. M., Mearns, L., Menéndez, C. G., Räisänen, J., Rinke, A., … Tignor, M. (2007). Regional climate Projections. In S. Solomon, Qin D., Manning M., Chen Z., Marquis M, Averyt K.B., Tignor M., & Miller H.L. (Eds.), Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

de Sousa, K., Sparks, A., Ashmall, W., van Etten, J., & Solberg, S. (2020). Chirps: API Client for the CHIRPS Precipitation Data in R. Journal of Open Source Software, 5(51), 2419. https://doi.org/10.21105/joss.02419

Department of Water Supply. (2017). Septic tank design.

DEVEX. (2021a). Ministry of Agriculture and Forestry (Laos). https://www.devex.com/organizations/ministry-of-agriculture-and-forestry-laos-125739

DEVEX. (2021b). Ministry of Industry and Commerce (Laos). https://www.devex.com/organizations/ministry-of-industry-and-commerce-laos-114631

Djondo, Y. (2020). A comparative assessment of sanitation governance: a study of Cambodia, Indonesia, and Laos.

DoNRE. (2018). Integrated Spatial Planning of Xamneua District.

DoNRE. (2022). Personal Communication.

DPWT_Huaphan. (2019). Decree on role and responsibility of Sector of Housing-Urban Planning and water supply (SHUP) Unit 1: General Provisions.

DPWT. (2022). Personal Communication.

Earth data. (n.d.). NASA Dataset. SRTM 30 (NASA Shuttle Radar Topography Mission Global 1 Arc Second V003) . Retrieved November 30, 2021, from https://search.earthdata.nasa.gov/

FAO. (2021). Resilient COVID-19 recovery and transformational pipeline to boost climate actions in agriculuture, land and water sectors in Lao PDR. In Grenn Climate Fund (Issue December). http://www.fao.org/3/cb3688en/cb3688en.pdf

Ferronato, N., & Torretta, V. (2019). Waste Mismanagement in Developing Countries: A Review of Global Issues. International Journal of Environmental Research and Public Health, 16(6), 1060. https://doi.org/10.3390/ijerph16061060

GoLPDR, G. of L. P. D. R. (2014). "Implementation of Social – economic Development, 5-year Plan No. VII (2009-2014) and Social Economic Development 5-year plan No. VIII (2014- 2019) of Sam Neua district.

Goudineau, Y. (2015). The Ongoing Invention of a Multi-Ethnic Heritage in Laos 1. The Journal of Lao Studies, 2, 33–53. www.laostudies.org

GWP. (2011). What is IWRM? – Global Water Partnership. Central and Eastern Europe, towards a Water Secure World. https://www.gwp.org/en/GWP-CEE/about/why/what-is-iwrm/

Haase, D. (2015). Reflections about blue ecosystem services in cities. Sustainability of Water Quality and Ecology, 5, 77–83. https://doi.org/https://doi.org/10.1016/j.swaqe.2015.02.003

Hearn, G., Howell, J., & Hunt, T. (2020). Performance of slope stabilization trials on the road network of laos. In Quarterly Journal of Engineering Geology and Hydrogeology (Vol. 54, Issue 1). Geological Society of London. https://doi.org/10.1144/qjegh2020-064

Heinimann, A., Hett, C., Hurni, K., Messerli, P., Epprecht, M., Jørgensen, L., & Breu, T. (2013). Socio-Economic Perspectives on Shifting Cultivation Landscapes in Northern Laos. Human Ecology, 41(1), 51–62. https://doi.org/10.1007/s10745-013-9564-1

Hou, L., Shusheng Liu, Linnan Guo, Fuhao Xiong, Chao Li, Meifeng Shi, Qiming Zhang, Siwei Xu, & Songyang Wu. (2019). Geology-Geochronology-and-Hf-Isotopic-Composition-of-the-Pha-Lek-Fe-Deposit-Northern-Laos. Earth Science, 30(1), 109–120.

Hussain, S., Khan, N., Gul, S., Khan, S., & Khan, H. (2020). Contamination of Water Resources by Food Dyes and Its Removal Technologies. In Water Chemistry. IntechOpen. https://doi.org/10.5772/intechopen.90331

Ingxay, P. ., Yokoyama, S. ., & Hirota, I. (2015). Livelihood factors and household strategies for an unexpected climate event in upland northern Laos. Journal of Mountain Scienc, 12(2), 483–500. https://doi.org/10.1007/s11629-013-2879-y

IPCC. (2012). Annex 1: Glossary of Terms. Lime and Limestone, 403–424. https://doi.org/10.1002/9783527612024.oth1

IPCC. (2014). Climate Change 2014: Impacts, Adaptation and Vulnerability. Cambridge University Pres. https://doi.org/10.1017/CBO9781107415386

IPCC. (2022). Climate Change 2022: Impacts, Adaptation and Vulnerability.Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change (D. C. R. M. T. E. S. P. K. M. A. A. M. C. S. L. L. V. M. A. O. B. R. H.-O. Pörtner (ed.)). Cambridge University Press. https://doi.org/10.1017/9781009325844

ITT. (2022). Information gathered from different sources, but compilled together from ITT staff.

IUCN. (2016). Nature-based solutions to address global societal challenges. In Nature-based solutions to address global societal challenges. IUCN International Union for Conservation of Nature. https://doi.org/10.2305/iucn.ch.2016.13.en

IWA. (2016). 2nd Edition For Urban Stakeholders to Develop a Shared Vision and Act towards Sustainable Urban Water in Resilient and Liveable Cities Principles Water Wise Cities for. https://iwa-network.org/wp-content/uploads/2016/10/IWA_Brochure_Water_Wise_Communities_SCREEN-1.pdf

JICA. (2017). Strategy of Wastewater Management for Vientiane Capital.

K4D Lao PDR. (2022). Incidence map of poverty in Sam Neau town and district.

Kanemaru K., Muhammad R., & Hirota I. (2014). Analysis of Monsoon Climate Variability for Swidden Agriculture in Northern Laos. In Integrated Studies of Social and Natural Environmental Transition in Laos (pp. 85–97). Springer. https://link.springer.com/chapter/10.1007/978-4-431-54956-7_5

Lacombe, G., Douangsavanh, S., Vongphachanh, S., & Pavelic, P. (2017). Regional assessment of groundwater recharge in the lower mekong basin. Hydrology, 4(4). https://doi.org/10.3390/hydrology4040060

Lainé, E. (2015). Urban Development and New Actors in Lao PDR in the Context of Regionalization: Case Studies of two Border Towns. Moussons, 25, 99–122. https://doi.org/10.4000/moussons.3258

Lao PDR Goverment. (2021a). Home | Ministry of Public Works and Transport. https://www.mpwt.gov.la/en/

Lao PDR Goverment. (2021b). Ministry Of Planning And Investment | Investment Promotion Department. https://investlaos.gov.la/about-us/ministry-of-planning-and-investment/

Lao PDR Goverment. (2021c). Obligation – Ministry of Industry and Commerce. http://www.moic.gov.la/?page_id=242&lang=en

Lao Statistical Bureau (LSB). (2018). Lao Population Projections 2015–2045.

Lao Statistics Bureau (LSB). (2015). Results of Population and Housing Census 2015.

Lehner, B., & Grill, G. (2013). Global river hydrography and network routing: Baseline data and new approaches to study the world's large river systems. Hydrological Processes, 27(15), 2171–2186. https://doi.org/10.1002/hyp.9740

McNamara, I. (2019). PolyUrbanWater Mission report – Laos 2019. https://www.youtube.com/watch?v=zTqE-8j9Unw

Ministry of Public Works and Transport. (2010). URBAN PLANNING MANUAL.

Ministry of Public Works and Transport. (2011). Urban Planning Improvement Project for Sam Neua Town.

Ministry of Public Works and Transport. (2018). Corporate Plan 2018- 2022.

Ministry of Public Works and Transport. (2020). Summary of volume amount distributed by each factory.

Ministry of Public Works and Transport. (2021). Lao People's Democratic Republic Ministry of Public Work and Transport National Progress Report on the Implementation of the New Urban Agenda.

Miyahigashi, A., Hara, H., Hisada, K. ichiro, Nakano, N., Charoentitirat, T., Charusiri, P., Khamphavong, K., Martini, R., & Ueno, K. (2017). Middle Triassic foraminifers from northern Laos and their paleobiogeographic significance. Geobios, 50(5–6), 441–451. https://doi.org/10.1016/j.geobios.2017.09.004

MONRE, M. of N. R., Environment, & DWR, D. of W. R. (2015). National Integrated Water Resources Management Support Program (ADB TA 7780) Outcome Study Report. November. https://www.dfat.gov.au/sites/default/files/laos-national-integrated-water-resources-management-support-program-ind-eval.pdf

MPWT. (2018). Terms of References.

Muñoz Sabater, J. (2019). ERA5-Land monthly averaged data from 1981 to present. In Copernicus Climate Change Service (C3S) Climate Data Store (CDS).

Njoku, P. O., Edokpayi, J. N., & Odiyo, J. O. (2019). Health and Environmental Risks of Residents Living Close to a Landfill: A Case Study of Thohoyandou Landfill, Limpopo Province, South Africa. International Journal of Environmental Research and Public Health, 16(12), 2125. https://doi.org/10.3390/ijerph16122125

Pathoummady, & S. (2010). Status of Meterological Network, Observations and Data Management in Lao PDR. In JMA/WMO Workshop on Quality Management in Surface, Climate and Upper-air Observations in RA II (Asia). https://doi.org/10.VII.2010

PNP. (2020). Household Survey on water supply.

PUW. (2019). Xam Neua, Lao PDRPolyUrbanWatersMission 2 Findings.

PUW. (2021). Interview management officer of Sam Nuea Water Supply or Sam Nuea Nam Papa (SNP).

Sánchez-triana, E., Enriquez, S., Larsen, B., Brody, M., Strukova Golub, E., Ward, W., Guerra Lopez, M. G., Sattler, K., Scandizzp, P. L., Cufari, D., Pierleoni, M. R., Morgenstern, R., & Ruitenbeek, J. (2021). Environmental Challenges for Green Growth and Poverty Reduction : A Country Environmental Analysis for the Lao People ' s Democratic Republic. In The World Bank. http://hdl.handle.net/10986/36266

Schmidt, S., Duangdala, P., Saysanasongkham, B., Sabir, H., Brenner, S., Schmid, M., Kuehn, T., & Hoehn, T. (2016). Neonatal mortality and morbidity in regional provincial hospitals in the People's Democratic Republic of Laos. Journal of Tropical Pediatrics, 62(3), 213–219. https://doi.org/10.1093/tropej/fmv101

SERVIR Mekong. (n.d.). Regional Land Cover Monitoring System. In Available from: https://landcover-mapping.org/en/ .

STP LDN. (2020). National Report on Land Degradation Neutrality Target Setting Programme : Lao PDR. October.

Sutton, M. A. ., van Grinsven, H. ., Billen, G. ., Bleeker, A. ., Bouwman, A. F. ., Bull, K. ., Erisman, J. W. ., Grennfelt, P. ., Grizzetti, B. ., Howard, C. M. ., Oenema, O. ., Spranger, T. ., & Winiwarter, W. (2011). Summary for policy makers. The European Nitrogen Assessment. https://doi.org/10.1017/cbo9780511976988.002

Toda, O., Tanji, H. A. J. I. M. E., Somura, H. I. R. O. A. K. I., Higuchi, K. A. S. T. U. H. I. R. O., & Yoshida, K. O. S. H. I. (2004). Evaluation of tributaries contribution in the Mekong River Basin during rainy and dry season. 2nd Asia Pacific Association of Hydrology and Water Resources Conference , 239–248.

UCRSEA. (2017). UNDERSTANDING INSTITUTIONAL CHALLENGES FOR URBAN PLANNING IN VIENTIANE CAPITAL, LAO PDR. http://ucrsea.ca/wp-content/uploads/2017/07/Urban-Planning-in-Vientiane-brief-Daniel-Hayward.pdf

Ulrich, A., Gutterer, B., & Reuter, S. (2009). Decentralised Wastewater Treatment Systems (DEWATS) and sanitation in developing countries : a practical guide. Water Engineering and Development Centre (WEDC), Loughborough University.

UN. (2020). Final UNPF Progress Report 2019.

UNDP-SIWI Water Governance Facility. (2017). The process of developing the water supply and sanitation strategy for emerging towns in Laos. www.watergovernance.org

UNEP. (2019). Disasters and Ecosystems: Resilience in a Changing Climate Source Book. www.unenvironment.org

UNICEF. (2019). The Situation of Children and Women: Lao People's Democratic Republic. UNICEF.

United Nations Population Division. (2018). World Population Prospects: The 2018 Revision. http://Data.Un.Org/Dat.Aspx?Q=life+expectancy+lao&d=PopDiv&f=variableID%3A68%3BcrID%3A418. http://data.un.org/Data.aspx?q=life+expectancy+lao&d= PopDiv&f=variableID %3A68%3BcrID%3A418

UNSD, U. N. S. D. (1992). United Nations Conference on Environment & Development Rio de Janerio, Brazil, 3 to 14 June 1992 AGENDA 21. http://www.un.org/esa/sustdev/agenda21.htm.

UNU-INWEH. (2013). Water Security & the Global Water Agenda. The UN-Water Analytical Brief. In Journal of Chemical Information and Modeling, 53(9).

VFI. (2019). Environment and agricultural investment in Lao PDR: An assessment of impacts, gaps and needs of agricultural investors, local authorities and communities affected by investments.

Viossanges, M., Pavelic, P., Rebelo, L. M., Lacombe, G., & Sotoukee, T. (2018). Regional mapping of groundwater resources in data-scarce regions: The case of Laos. Hydrology, 5(1). https://doi.org/10.3390/hydrology5010002

Vongvisouk, T., Broegaard, R. B., Mertz, O., & Thongmanivong, S. (2016). Rush for cash crops and forest protection: Neither land sparing nor land sharing. Land Use Policy, 55, 182–192. https://doi.org/10.1016/j.landusepol.2016.04.001

Wang, J., Sui, L., Yang, X., Wang, Z., Ge, D. ., Kang, J., Yang, F., Liu, Y., & Liu, B. (2019). Economic Globalization Impacts on the Ecological Environment of Inland Developing Countries A Case Study of Laos from the Perspective of the Land UseCover. Sustainability, 11(4), 3940.

WEPA. (2013). Outlook on Water Environmental Management 2012.

WEPA. (2021a). Policies: Legislative framework Lao PDR. http://www.wepa-db.net/policies/measures/currentsystem/laos.htm

WEPA. (2021b). State of water environmental issues Lao PDR Groundwater. http://www.wepa-db.net/policies/state/laos/groundwater.htm

World Bank. (2022). Lao PDR Economic Monitor.

World Health Organization. (2015, November 19). Stunting in a Nutshell. Departmental News.

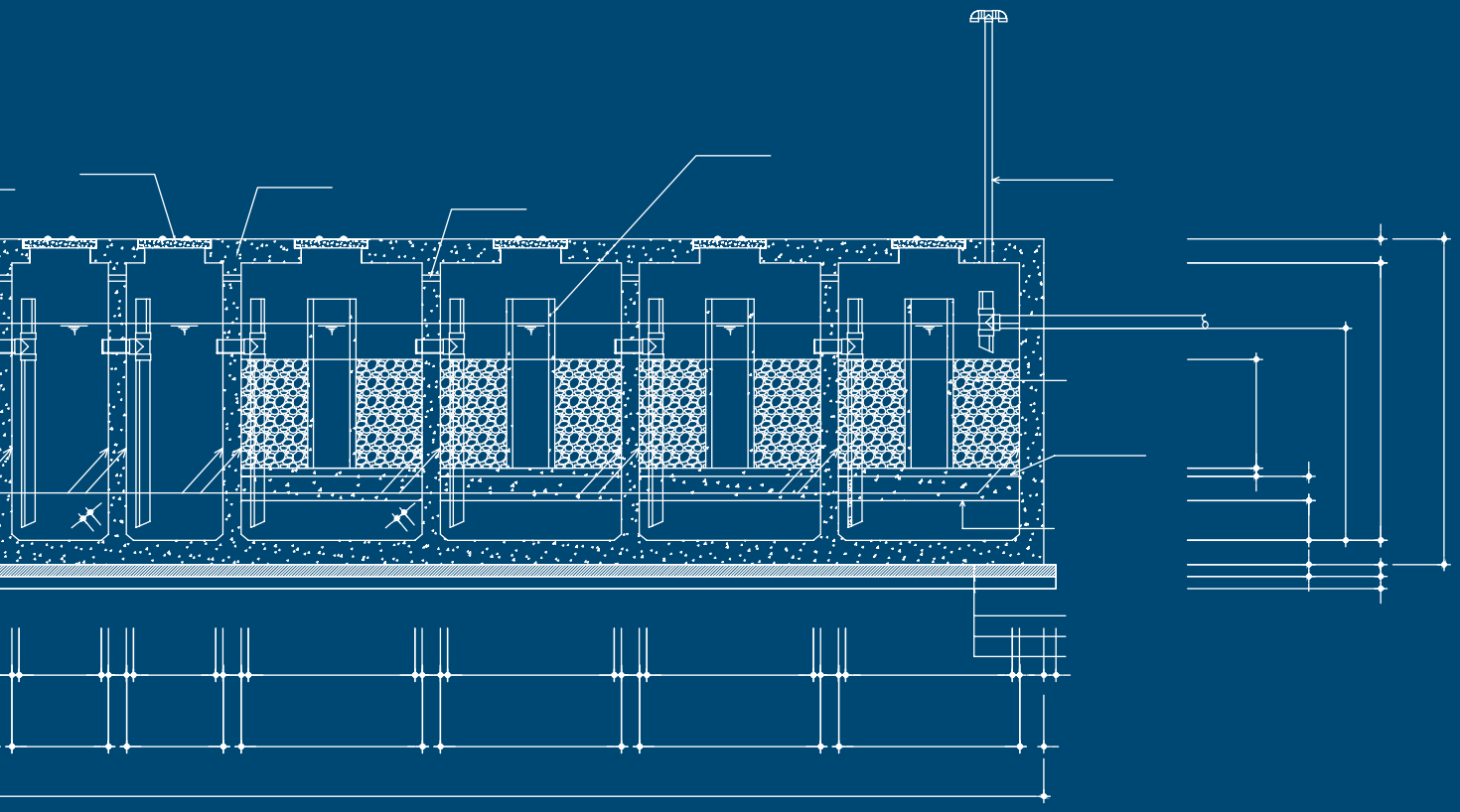
Yadav, H., Kumar, P., & Singh, V. P. (2019). Hazards from the Municipal Solid Waste Dumpsites: A Review (pp. 336–342). https://doi.org/10.1007/978-3-030-02707-0_39

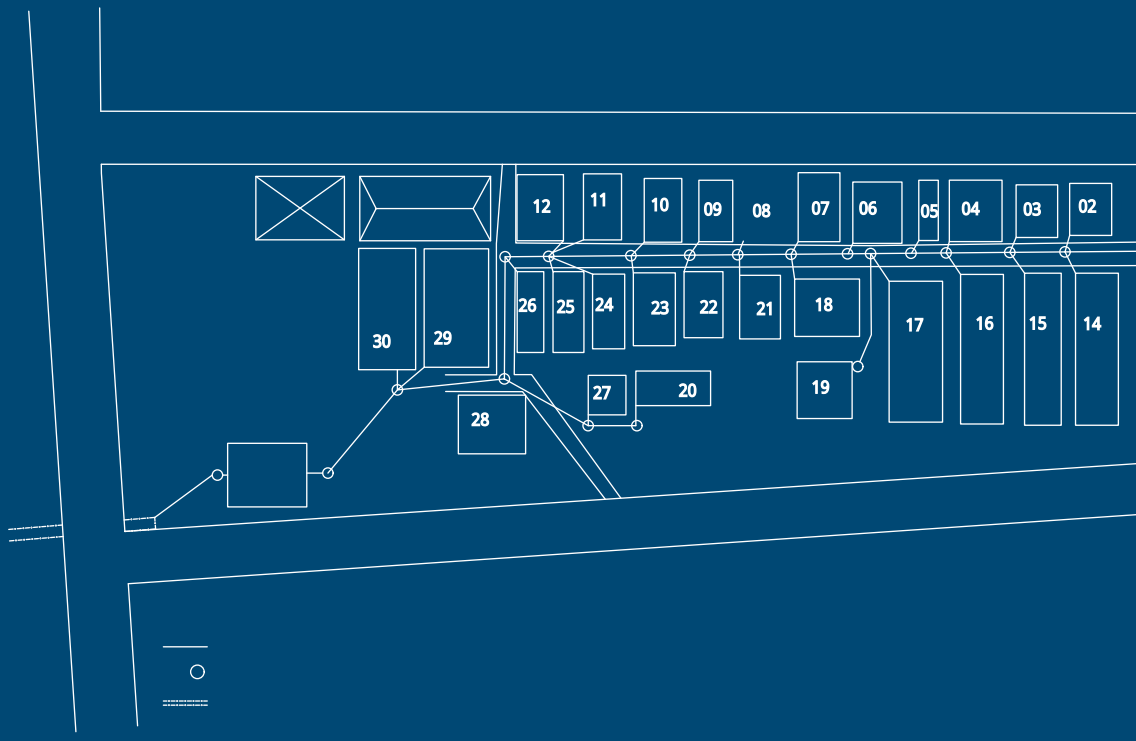
Zanaga, D., Van De Kerchove, R., De Keersmaecker, W., Souverijns, N., Brockmann, C., Quast, R., Wevers, J., Grosu, A., Paccini, A., Vergnaud, S., Cartus, O., Santoro, M., Fritz, S., Georgieva, I., Lesiv, M., Carter, S., Herold, M., Li, L., Tsendbazar, N. E., … Arino, O. (2021). ESA WorldCover 10 m 2020 v100. https://doi.org/10.5281/zenodo.5571936

Zech, W., & Hintermaier-Erhard, G. (2002). Böden der Welt. Elsevier GmbH, Spektrum Akademischer Verlag Heidelberg.

Zhang, Y. ., Li, T. ., Wang, B. ., & Wu, G. (2002). Onset of the Summer Monsoon over the Indochina Peninsula: Climatology and Interannual Variations *. Journal of Climate, 15(22), 3206–3221.

Annexes
I. — XIX.

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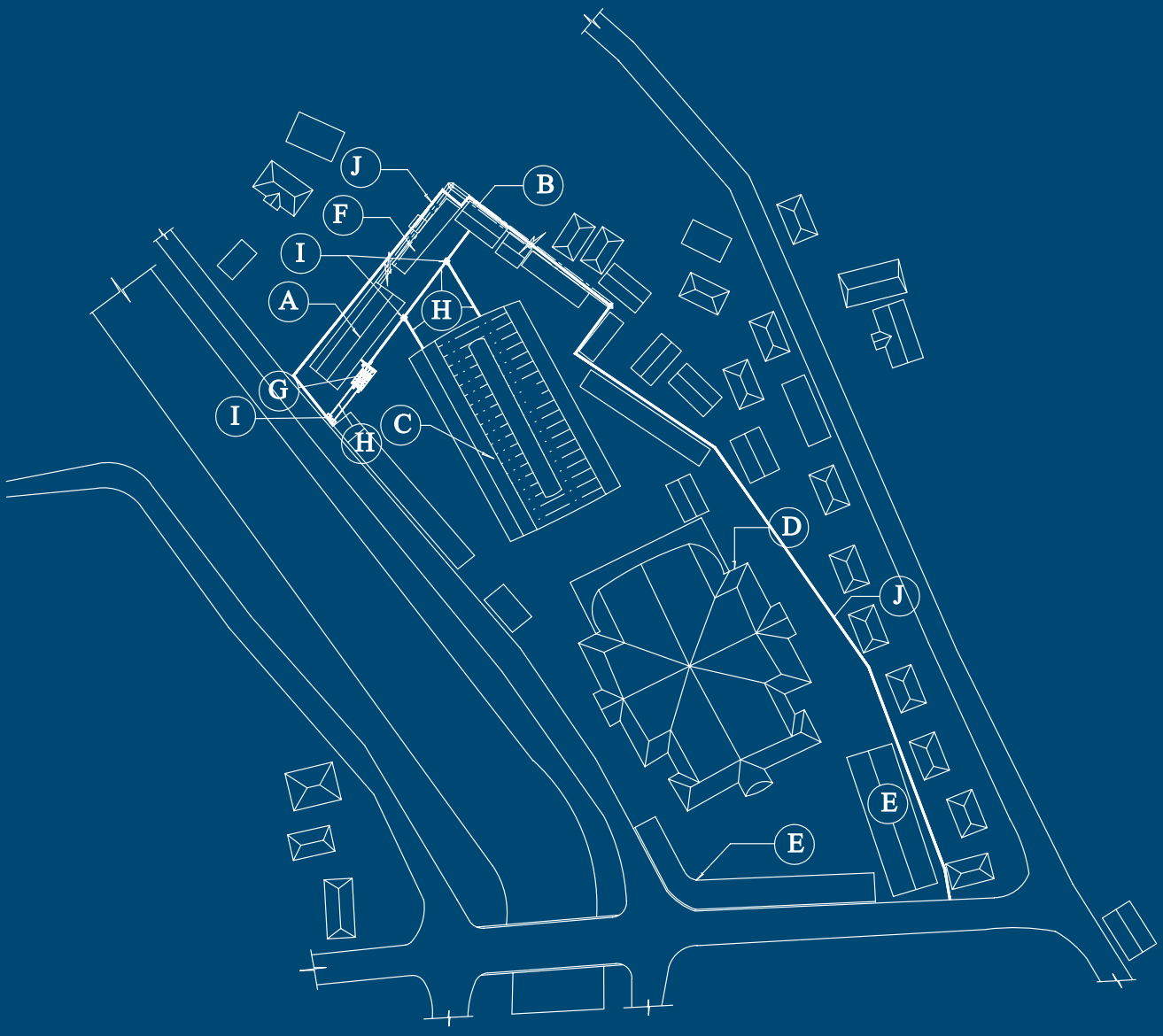
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Annex I.
Population Growth Projections for Sam Neua Compared to other Laotian Towns

Table 2. Population growth projections for Sam Neua compared to other Laotian towns

Name	2015	2030	2045
Vientiane Capital	505 672	1 114 172	1 571 365
Pakse	60 687	321 901	595 444
Phonesavanh	35 496	171 951	378 457
Savannaketh	70 999	208 955	358 470
Luang Prabang	57 265	145 649	232 283
Sayaburi	23 223	84557	161 349
Oudomxay	21 303	57 340	94 074
Houaixay	16 547	52 601	93 783
Sam Neua	**17 461**	**46 055**	**74 795**
Luang Namtha	16 902	44 139	71 329
Thakek	30 829	50 881	65 366
Sekong	11 727	27 803	42 810
Salavanh	9 651	24 276	38 502
Pakxanet	15 178	26 457	34 931
Attapeu	14 672	24 549	31 754

Source: (CDE, 2018)

Annex II.
Key Stakeholders in National and Local Urban Planning Process

- The key stakeholders and public actors in centralized urban planning include:
- The Ministry of Public Works and Transport (MPWT) is mandated with the macro-management of housing, urban planning, transport, roads and waterways in Lao PDR.
- The Department of Housing and Urban Planning (DHUP) oversees the laws, decrees, regulations, budgets and training governing the planning of urban areas.
- The Ministry of Planning and Investment (MPI) has the mandate to attract and manage investment for urban development including FDI.
- The Ministry of Natural Resources and the Environment (MoNRE) is the key actor in land management, and in charge of the development and implementation of national policies on climate change.
- The Ministry of Labor and Social Welfare (MLSW) is in charge of labor rights, migration, and for the coordination of preparedness and emergency response to natural disasters.
- The Public Works and Transport Institute (PWTI) is tasked with the technical production of urban plans (CDE, 2018).

The key public actors at sub-national levels include:

- Division of Public Works and Transport (DPWT): Management of non-core urban areas of Vientiane Capital and other cities, with a focus on housing; planning; and transport, roads and waterways.
- Office of Public Works and Transport (OPWT): Management of public works and transport at district level in urban areas.
- Vientiane Town Office for Management and Services (VCOMS, formerly VUDAA): Municipal organization, managing the greening and cleaning in core urban areas of Vientiane Capital.
- Urban Development Administration Authority (UDAA): Urban organizations in the main towns (Pakse, Thakhek, Savannakhet, Luang Prabang) initially meant to be tasked with overall urban management, they are currently largely tasked with urban greening activities (CDE, 2018).

Annex III.
Steps and Methodology for Preparing Urban Plans in Laos

Figure 104. Steps and methodology for preparing urban plans in Laos

Source: (Ministry of Public Works and Transport, 2011)

1 Identifying the scope of urban planning

STEP 1: Gathering of existing documents and preparation for preliminary survey
STEP 2: Undertaking preliminary survey of the area to be covered by the plan
STEP 3: Holding local consultation
STEP 4: Finalising the contract with the relevant administration
STEP 5: Considering next steps after signing the contract

2 Data collection and analysis

STEP 1: Preparing a work schedule and budget for each survey team
STEP 2: Preparing base maps based on GIS software
STEP 3: Informing DPWT before undertaking field survey
STEP 4: Visiting DPWT before undertaking field work
STEP 5: Undertaking a topographic survey
STEP 6: Meeting with DPWT at the end of topographic survey
STEP 7: Preparing topographic map and report of survey
STEP 8: Undertaking other field surveys and interviews
STEP 9: Holding a meeting before leaving the area

3 Draft of urban master plan

STEP 1: Building up database and preparing maps and plans using GIS software
STEP 2: Analysing survey data from various sources including trend analysis
STEP 3: Beginning to prepare the first draft report
STEP 4: Preparing planning options for future development
STEP 5: Consultations on planning options
STEP 6: Preparing a plan for proposed road network and identify a hierarchy
STEP 7: Preparing a proposed land use plan
STEP 8: Preparing a plan of proposed drainage and solid waste management systems
STEP 9: Identifying the priority projects on the plan
STEP 10: Preparing the final report of the existing situation, trends and proposals
STEP 11: Preparing regulations governing the use of land

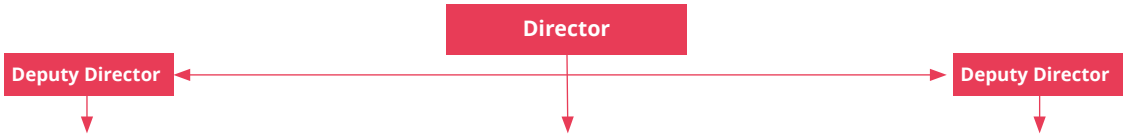
4 Invitation of stakeholders to a consultation meeting

STEP 1: Consultation with MWPT
STEP 2: Meeting DWPT and OPWT before approaching the village administration
STEP 3: Holding a meeting of village administration in the area covered by the urban plan
STEP 4: Holding a consultation meeting with relevant stakeholders at the district level
STEP 5: Meeting DPWT again before the consultation meeting at the provincial level
STEP 6: Holding a consultation meeting with the relevant stakeholders at the provincial level

Figure 105. Roles and Responsibilities of Sector of Housing-Urban Planning and Water Supply

Source: (Ministry of Public Works and Transport, 2011)

Annex IV.
Provincial Level Roles and Responsibilities for Sector of Housing-Urban Planning and Water Supply (SHUP)



Housing Unit

- Expansion policy, strategy plan and development plan of unit (short, middle and long time period)
- Publication policy, strategy plan and regulations related to construction and renovation, and construction materials for housing
- Survey and statistic data collection, survey-design, calculation and writing proposals related to housing construction, renovation and construction materials in the province
- Consideration and recommendations to undertake investments on suspended and canceled projects
- Monitoring and management of the investors that do business in housing construction, renovation, survey-design as well as consulting companies
- Collecting data-statistic as well as protection of Lao architecture, archaeological site, cultural-historical and natural heritage
- Coordination and collaboration with foreign, regional and international stakeholders according to assignment
- Reporting on implementation construction works of the unit to higher and provincial levels
- Promotion of applying new methods and technologies in survey-design related to construction and renovation of housing
- Collaboration with related departments on publication and expansion of regulations on construction and construction materials
- Management and checking of quality testing, material production and issuing standard certificates for material which is produced internally and imported. Recommendation on proper use of construction materials

Urban Planning Unit

- Documentation and data management in the sector
- Management of tools, equipment and vehicles of the sector
- Monitoring staff works and financial management according to the regulations
- Research on urban planning for municipality of the province, coordination with each district to research urban planning on municipality level, monitoring at the local level of the implementation, management of urban planning works according to the regulations
- Consideration of any construction that has impact on urban plans such as construction in the area of natural disasters mountains, water body banks, green areas forests airports and transportation stations
- Monitoring of construction and renovations to be in accordance with urban plans and regulations
- Checking and issuing urban planning certificates, construction and renovation permits and accuracy certificates for buildings
- Following the regulations on land use in the areas that do not have urban plans by collaboration with Land Sector and local authorities
- Planning and collecting nationwide statistical data, information related to urban planning (short, middle and long period)
- Management and inspection of implementation of the urban planning law
- Data collection, survey-design, calculation and writing proposals according to regulations. Implementation of urban development plans which consider environmental and urban protection regulations
- Reporting, consultation and exchange on city development and environment with authorities and related departments to identify solutions on environmental issues
- Receiving and description of any public offer from any sectors that relates to city development and environment
- Checking, considering and writing recommendations for investments and approval, suspension, canceling of the projects
- Collection, summery, research, orders decrees laws and regulations which relate to city development and environment
- Capacity building to staff on city development and environment training, awareness raising and education on city development and environment to public

Water Supply Unit

- Expansion policy, strategy plan and development plan of unit (short, middle and long time period)
- Publication of policy, strategy plan and regulations related to water supply and sanitation
- Order, monitoring and inspection of construction infrastructure on water supply and sanitation in Huaphan province
- Survey and statistical data collection, survey-design, calculation and writing proposals related to water supply and sanitation and water source for tap water production in the future
- Coordination with related departments on model of water supply fee in the province → proposal for water supply state-enterprise → to be aproved by provincial administrative council → to provincial governor for approval
- Participation in resolving the conflicts between the water service provider and the user.
- Accompany and support water supply state-enterprise of Huaphan in reporting on implemented water supply work to higher level and provincial office
- Management, monitoring and inspection of infrastructure construction on water supply and sanitation in Huaphan province

Annex V.
Actors and Legal Framework in regard Water Resources

Actors influencing water resources management

Lao PDR's diverse natural resources stocks are receiving a lot of attention under a growing economic growth scenario during the last decades, where over exploitation, pollution, and general detriment ignites the main challenges for the country's environment (FAO, 2021; Sánchez-triana et al., 2021). Acknowledging the need to protect and regulate the available natural resources, Lao PDR government have created a policy framework to the present purpose. The subsequent are the main actors (institutions) involved in developing and implementing the framework.

The Lao PDR structure of the institutional actors for environmental management is composed of (i) national-level ministries and agencies in charge of protecting and conserving the environment, (ii) provincial and district entities that develop environmental management at smaller scales, and (iii) mass organizations that supports the government on public campaigns and awareness (Sánchez-triana et al., 2021)).

National Level

The Ministry of Natural Resources and the Environment (MoNRE)

By acting as a key regulator for direct management of land, forest, water, air, biodiversity, and raw materials, the MoNRE strives to improve coordination, collaboration, and integration of natural resources and environment management. The action range also includes the management of climate change, disaster and meteorology, and hydrology (FAO, 2021; Lao PDR Goverment, 2021a; Sánchez-triana et al., 2021).

A major responsibility of the MoNRE in the area of water management is the implementation of the National Law on Water Resources (LWWR), including the issuance and management of licences for water use. It has government and management roles on issues related to the management of resources and natural environment, including land, water, air, biodiversity, environmental and social nature, including disaster and natural protection from changing weather, equipment, popular and hydrology across the country. Local authorities (municipal, district, city, village) have similar responsibilities at the provincial and local levels (MONRE et al., 2015; Sánchez-triana et al., 2021).

There are two departments under MoNRE with significangt importance on water resources:

- The Department of Water Resources (DWR)
- The Division of Groundwater Management (DGM) which will be responsible for:

  a) the development and management of groundwater resources (from the quantity and quality perspectives) at national, river-basin, provincial and district levels, in cooperation with line agencies,

  b) planning of permits for resources access and use,

  c) establishment of a database system and provide advice on technical matters, monitoring, evaluation and support activities to line agencies and other sectors.
- Natural Resources and Environment Institute (NREI) which falls under the MoNRE is responsible for providing technical and research-oriented support to the DGM.

Ministry of Agriculture and Forestry (MAF)
The MAF is responsible for ensuring a sustainable agriculture development and forest management for food, security nutrition and resilient livelihoods (FAO, 2021). In terms of the water sector, the MAF oversees the infrastructure development, such as sewage treatment plant development. The same way acting under the LWWR framework, managing water resources for irrigation, fishing, agriculture and forestry production are the responsibility of the MAF (MONRE et al., 2015; Sánchez-triana et al., 2021).

Acting as a key regulator, the MAF promote appropriate and wise policies in the field of agriculture and forestry, as well as the basis for the gradual construction and development of domestic forestry and agricultural industries. By improving the standards of the production process, while restoring the nature basic structures, are the mechanisms to encourage local leaders, to introduce new technologies and techniques into farms for food and timber production (DEVEX, 2021).

The Ministry of Planning and Investment (MPI)
The MPI is a government agency responsible for governmental and regional planning and investment management, research strategies, master plans, planning of the National Socio-Economic Development Plan (NSEDP), and mechanisms and policies related to the economy. Governance, statistics, promotion and management of domestic and foreign private investment in PDR Laos, attracting and seeking support (Official Development Assistance: ODA) and international cooperation are also within its remit (Lao PDR Goverment, 2021b).

MPI consists of a permanent secretariat and 12 departments and secretariat: Permanent Secretary Office, Department of Organization and Personnel, Inspection Department, Legal Affairs Department, Department of Planning, Department of Evaluation, Investment Promotion Department, Department of International Cooperation, Special Economic Zones Promotion and Management Office, Lao-Vietnam Cooperation Committee Office, Lao-China Cooperation Committee Office and Centre for Development Policy Research.

The Ministry of Public Works and Transport (MPWT)
The MPWT is a government department with the role of chief executive officer of the government in the macro management of the country's transport sector, land, water, aviation, railway, construction urban planning and water sector (Lao PDR Goverment, 2021a). Under the LWWR, water supply, navigation and waterway transportation, bank-erosion protection, and wastewater collection and treatment are the responsibility of the MPWT (MONRE et al., 2015; Sánchez-triana et al., 2021).

MPWT consists of a permanent secretariat and 12 departments and Institute: Permanent Secretary Office, Department of Personnel, Department of Inspection, Department of planning and Finance, Department of Waterways, Department of Roads, Department of Transport, Department of Housing and Urban Planning, Department of Water Supply, Department of Civil Aviation, Department of Railways and the Public Works and Transport Institute.

Departments under DHUP with relevance to water resources are as follow:

- Department of Housing and Urban Planning (DHUP) is responsible for planning of towns and other urban centers.
- Department of Water Supply

The River Basin Committees
The River Basin Committes have been given the mandate (No. 293/PM, dated 15/06/2010) to act as a water resources executive in river basins under the direction of the Lao National Mekong Committee (LNMC) for the management, development, conservation, rehabilitation, and utilization of water resources in river basins. The NNRBC was founded by Decision No. 10/PM dated 9/01/2013 (ADB, 2014), and among its tasks are:

- The NNRB's formulation of water resource management strategies, action plans, and regulation; and
- Submission to higher-level entities for review, approval, and implementation oversight (Art. 5.1).

Ministry of Industry and Commerce (MoIC)
The MoIC is responsible for coordinating the trade-related and Development Facility (TDF) Multi-Donor Trust Fund under the Department of Foreign Assistance, Ministry of Planning and Cooperation. By Supporting the Lao Government's National Socio-Economic Plan Development Plan (NSEDP), facilitating the cross-border movement of trade and goods, and strengthening the Government's capacity to carry out specific tasks relevant to the region. Implementing the TDF will reduce poverty and support economic development and the global economic integration (DEVEX, 2021b; Lao PDR Goverment, 2021c).

Under the LWWR, managing water resources in industrial processing is the responsibility of the MoIC (MONRE & DWR, 2015; Sánchez-triana et al., 2021).

MoIC consists of a permanent secretariat and 14 departments: Department of Industry and Handicrafts, Department of Small and Medium Enterpise Promotion, Department of Enterprise Registration and Management, Department of Domestic Trade, Department of Inspection, Permanent Secretary Office, Department of Organization and Personnel, Institute for Industry and Commerce, Department of Planning and Cooperation, Department of Import and Export, Department of Trade Promotion, Department of Foreign Trade Policy, Department of Standardization and Metrology and Department Of Intellectual Property.

Ministry of Health (MoH)
The Ministry of Health of Laos is responsible for providing health services in the country, including nutrition and COVID19 response. Under the LWWR, the inspection of water sources used for drinking and clean water supply for people living in rural areas, and surveillance of water quality for drinking and consumption, are the responsibility of the MoH (MONRE et al., 2015; Sánchez-triana et al., 2021).

Provincial and District Level

According to the institutional structure of environmental management in Lao PDR, each ministry has different provincial and district entities that implement various measures required to manage the natural resources and the environment at the provincial and local level.

An example of the hierarchy is water resource management at the local level, where approval of the River Basin Management Plan, water allocation, reservoir areas in their jurisdictions and dealing with water deterioration, takes place to fulfil the LWWR. All these actions are the responsibility of the different local administrations (MONRE et al., 2015; Sánchez-triana et al., 2021).

A brief description of the main roles of provincial and local level entities is given below.

Department of Water Supply (DWS)

- The DWS is responsible for the water supply and sanitation and wastewater sectors under each particular jurisdiction.

Department of Housing and Urban Planning (DHUP)

- The DHUP is responsible for urban water sector strategies and plans, technical standards and management of capital investments.

Division of Public Works and Transport (DPWT)

- Is responsible for planning (micro-level functional requirements, including septic tanks), macro-level functional requirements (SIPs) and municipal treatment plans.

Department of Natural Resources and Environment (DONRE)

- Has responsibility for policy and strategy related to system goals in terms of environment management.
- Is responsible for the controlling and regulatory activities for environmental pollution.

Urban Development Administration Authority (UDAA)

- Responsible for asset management (system inventory, inspection of asset condition).
- Accompanying activities are carried out by the UDAA, the advertising and public relations are made once a year.

Department of Irrigation (DoI)

- The collection and analysis of water quality (chemical and physical parameters) data is the responsibility of the Department of Irrigation (DOI).

Department of Industry and Handcrafts (DoIH)

- The Department of Industry and Handicraft (DOIH) within the Ministry of Industry and Commerce (MOIC) regulates and authorizes the activities of large companies, including their industrial effluents.

The main actors in Lao PDR work together under an inter-sectoral coordination, categorize the mechanisms of collaboration as formal forums including sector working groups (SWGs) and sub-sector working groups (SSWGs) on environment, health, and the agriculture and forestry sectors (Sánchez-triana et al., 2021).

For collaboration on specific topics, technical groups can be formed to assess and manage specific challenges, the technical groups are called Technical Working Groups (TEGs), where different Ministries though their departments work together.

Main Challenges

- Laos' environmental management framework is ineffective in mitigating environmental degradation due to gaps in environmental policies and weak enforcement of laws (Sánchez-triana et al., 2021).
- State regulators lack the resources to implement the regulatory framework. Because of this, enforcement is selective, and compliance is very low (FAO, 2021; Sánchez-triana et al., 2021).
- Weaknesses in decision implementation due to a lack of environmental funding and a reduction in government-wide environmental spending (Sánchez-triana et al., 2021).
- Limited publicly available data suggest that environmental protection isheavily reliant on donor funding, the overall allocation to the sector is declining, Government spending increased (Sánchez-triana et al., 2021).
- There is also an urgent need to strengthen the capacity of environmental organizations to implement decisions. MoNRE was founded in 2011 and is still in the process of consolidation. Although the sector employed more than 4,000 people in 2015, environmental agencies have been largely unable to perform key functions, such as monitoring and enforcing National Environmental Quality Standards (Sánchez-triana et al., 2021).

2. Institutional Framework for Environmental Regulation

National Level

National Natural Resources and Environment Strategy 2025 and Action Plan 2016–2020

The National Socio-Economic Development Plan 2011-2020, the National Strategies for Economic Development and Poverty Eradication, the 9th National Congress of the Lao People's Revolutionary Party, as well as regional and international orientations and policies like the MEAs and SDGs served as the foundation for the development of the 10-year National Natural Resources and Environment Strategy 2016-2025 (NRES 2025) (STP LDN, 2020). In order to effectively implement this plan, it is crucial to actively coordinate and work with all the relevant sectors and partners at the local, national, regional, and international levels, as well as to include the local population.

One of the main goals of the Strategy is to plan and manage in a sustainable way the natural resources, such as land, water, wetlands, forests, biodiversity and minerals. In terms of water resources, among other, it aims at implementing the integrated water resources management criteria in order to ensure the balance between the use of water resources for social and economic development, people's livelihood and ecological systems (STP LDN, 2020).

The Natural Resources and Environment Sector Vision (NRESV) towards 2030 and the Ten-Year Strategy (2016–2025)

In addition to offering a framework for other sectors to adopt to create synergies with the natural resources and environment sector, the NRESV is anticipated to direct the activities of several MoNRE units at the national, provincial, and district levels (Sánchez-triana et al., 2021).

Main goals of the strategy are as follows

- controlling land, water, and air pollution, as well as noise from agricultural and industrial operations and services in order to fulfill environmental regulations;
- protect water quantity and quality in ten river basins to meet water-quality and quantity standards and to ensure people's livelihoods;
- reduce the use of chemical substances in the development of industrial and agricultural sectors by 15% across the country to meet the chemicals and waste-reduction target in 2020.

Law on Water and Water Resources No. 02-96, dated 11 October 1996, amended in 2017

The Lao PDR's Water Law outlines the guiding principles, rules, and policies that must be followed for the sustainable management, exploitation, development, and use of water and water resources in order to meet both the country's demands and safeguard the environment (MONRE et al., 2015). Based on the Water Law, the Government has the authority to manage and distribute water use on behalf of the people. Except for small-scale use for domestic consumption and usage without any commercial aims, which does not require prior approval, people and organizations may only use water and water resources when the requisite authorisation has been granted by the competent authorities.

The 2017 Law on Water and Water Resources (LWWR) includes the requirement to maintain a minimum water flow in watercourses to guarantee that communities and ecosystems can satisfy their needs, as well as the creation of designated zones to safeguard drinking and consuming water (STP LDN, 2020).

Additionally, the government has the right to designate an area as a Protected Zone for Water and Water Resources, in which no one is allowed to engage in certain activities unless the government expresses and specifically approves them.

Law No.29, date 18 December 2012 on Environmental Protection

The Environmental Protection Law defines principles, regulations and measures relating to the management, monitoring, protection, control, preservation and rehabilitation of both natural environment and social environment (MONRE et al., 2015).

According to the Environmental Protection Law, everyone has a responsibility to protect the environment, which generally entails the following:

- protecting the environment from any natural or man-made disasters;
- limiting pollution so as not to exceed the national pollution and environmental quality standard; and
- controlling and properly disposing of toxic chemicals and waste.

Agreement No. 2734/PMO.WREA, dated 7 December 2009 on the National Environmental Standards

The National Environmental Standards serve as the foundation for environmental monitoring and pollution management in terms of ambient environmental limits and emission standards for water, soil, air, and noise.

The competent authority that will oversee and check for conformity with all the established regulating standards is the Ministry of Natural Resources and Environment. However, it should be mentioned that the National Environmental Standards are now being revised in order to reflect current events and to completely comply with the Environmental Protection Law in 2012 (MONRE et al., 2015).

The relevant legislations regard pollution control at national level are summarized in the table below.

Legislations	Description
The National Green Growth Strategy (NGGS) 2019	This strategy is intended to stimulate economic development while transitioning to a greener economy that invests in people and natural capital, protects the environment, and produces green employment.
National Environmental Standards (revised 2017)	The National Environmental Standards are defined as the foundation for environmental monitoring and pollution management in water, soil, air, and noise.
Decree on Environmental Impact Assessment (2010)	Supports the implementation of the Environmental Protection Act, particularly in respect to Environmental Impact Assessment. Establishes principles and norms, as well as mechanisms for the development, functioning, management, and monitoring of environmental impact assessments. Ensures that all domestic and foreign public and private investment projects operating in Lao PDR that have or may have negative environmental and social impacts are designed with the correct and appropriate environmental and social impact prevention and mitigation measures or environmental management and monitoring plans (EMMP) and social management and monitoring plans (SMMP). Effectively avoid, reduce, and resolve negative environmental and social consequences of investment projects.
Ministerial Instruction on the Process of Environmental and Social Impact Assessment of the Investment Projects and Activities	Support the implementation and expansion of the measures outlined in the Environmental Protection Act. This Instruction intends to maintain consistency in the conduct of Environmental and Social Impact Assessments by all public and private domestic and international enterprises operating in Lao PDR that create or are expected to cause environmental and social consequences. Those Investment Projects and Activities must undertake an effective Environmental and Social Impact Assessment, contribute to the country's long-term socio-economic growth, and both minimize and strengthen climate change adaption.
Ministerial Instruction on the Process of Initial Environmental Examination of the Investment Projects and Activities (2013)	This Instruction is for implementing and extending the provisions of the Law on Environmental Protection. This Instruction aims to ensure the uniformity in the conductance of the Initial Environmental Examination by every Investment Projects and Activities of a public and private both domestic and foreign enterprises which operate business in Lao PDR that cause or are likely to cause environmental and social impacts.

Table 3. Summary of related polution control legislation in Lao PDR

Source: Collected from different sources (ITT, 2022)

Legislations	Description
Tax Law (2011) Presidential Provision on Environmental Tax (2017-proposed)	Article 57 defines Environment tax as a direct tax imposed on individuals, legal entities and organizations permitted to conduct business activities, import [products and services] or use natural resources, which cause environmental pollution; negative impact on health of human, animal and plant and biodiversity. Article 58 identifies scope of environmental tax: Individuals, legal entities and organizations, including Lao nationals, aliens, foreign nationals and stateless persons permitted to conduct business activities, import [products and services] or use of natural resources, which cause pollution to environment in the territory of Lao PDR are obliged to pay environmental tax aimed to treat or restore or eliminate such pollution in order to retrieve suitable living conditions in the environment. Identify principles, regulations, environmental taxation rates. In addition, identifies necessary measures to manage and monitor, environmental protection and public health. Promotes investment and builds the government revenue sources to support environmental management in Lao PDR.
Law on Water and Water Resources (1996)	Determines the necessary principles, regulations, and measures relating to the administration, exploitation, use and development of water and water resources. Article 29 specifies that individuals, legal entities, or organizations have the obligations to preserve water and water resources, to not cause water to become shallower, to be depleted, to be polluted or to become noxious and to not cause damage to water, water resources, public property and the property of other individuals. Articles of: 30, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41 mention about the prohibition of discharges of wastewater, solid wastes, pollutants and effluent to water bodies and to land; the ambient water quality standards; wastewater discharge standards and wastewater discharge permits; the role of The Ministry of Natural Resources & Environment in responses to water pollution; groundwater protection; Protection of wetlands from unauthorized drainage.
Land Law (2003)	Determine the regime on the management, protection and use of land in order to ensure efficiency and conformity with [land-use] objectives. Land is classified into regions and categories (Article 11). Within each category, parcels of land may be assigned to specific uses or objectives. Article 60 stipulates obligation of land user not to cause damage to land quality and not to cause adverse impact to the natural or social environment, however the law does not provide information on quality standards.

Legislations	Description
Law on Agriculture (1998)	The Law on Agriculture has the function of determining principles, rules, and measures regarding the organization and activities of agricultural production which is the basis of the country's economy, including management and preservation of agricultural activities and production with the following aims: to encourage, promote, and expand agricultural production to guarantee the food supply and [to guarantee] commodity production; to create favorable conditions for building and expanding agro-industrial processing; to contribute to national economic growth; to make people wealthy; to strengthen the nation; and to avoid damaging and endangering the environment. Article 6 stipulates that Individuals and organizations undertaking agricultural production are obligated to protect the environment. Agricultural producers must use appropriate methods and measures to protect the land, water, forests, the air and others. Chapters provides provision on fertilizer and animal feeds, of which article 29 stipulates that the use of all types of fertilizer must be done properly and strictly according to rules relating to the use of fertilizers, such as using fertilizers according to their purpose, type and volume to [achieve] efficient use of [such] fertilizers, [and] ensuring that the fertilizers cause no danger to the lives or the health of people and animals. Similarly, Chapter 5 provides provision on pesticides and animal medicine, of which Article 34 stipulates that those using insecticides or animal medicines must strictly adhere to rules and regulations and use them in compliance with their intended purpose, including the storage of such substances for the efficient use of such insecticides or animal medicines, to ensure that there is no danger to health or to the lives of people or animals.
Law on Urban Plans (1999)	Determines principles, regulations and measures regarding the management, land use, construction and building of structures at national and local levels. Lacks any provision on urban environmental quality standards and infrastructure planning needs for urban environmental management.
Law on the Processing Industry (1999)	Determines principles, regulations, and measures relative to establishing, undertaking, and administering industrial and handicrafts processing activities to expand industry and handicrafts, interrelating the processing industry with agroforestry; transforming the natural economy of farmers into a goods-based economy, interrelating the economic structures of the agro-forestry, industry and services [sectors] to increase the living standards of the multi-ethnic peoples. Article 4 stipulates that the industrial and handicraft processing operations must assure environmental protection as provided for in the Law on Environmental Protection. Chapter 5 further stipulates provision on environmental protection including pollution control.

Annex VI.
Water Quality Results from May and July 2017

Table 4. Water Quality Results from May and July 2017

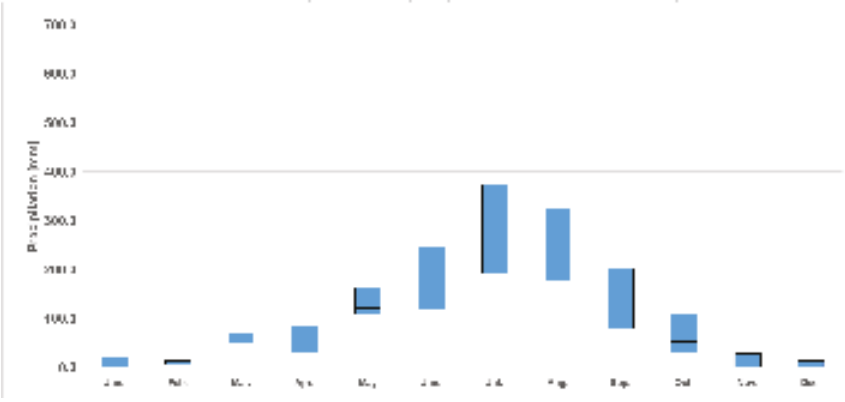
Source: Data replicated from (ADB, 2018)

Parameter	Unit	Standard	Nam Xam		Houay Man	Nam Sim	Ban Ngew Weir (Irrig. Dept.)
			Sampling Date				
			7/1/2017	7/24/2017	7/24/2017	5/10/2017	5/10/2017
Cyanide	mg/l CN	0,07		ND	ND		
Alkalinity	mg/l	na		57,1	18,1		
Arsenic	mg/l As	0,05		0,001	0,001		
Aluminium	mg/l Al	0,2	14,3				
Ammonium	mg/l as NH^{+}_{4}	<1.5	ND				
Calcium	mg/l Ca	na	11,9				
Color	Pt. Co	na	22	20	10	2,67	3,25
Iron	mg/l Fe	<1	16,8	0,718	0,452	4,43	0,23
Magnesium	mg/l Mg	na	3,39				
Manganese	mg/l Mn	<0.5	0,29	0,129	0,071	0,24	0,02
Nitrate	mg/l as NO_3	50	0,85				
Permanganate (as a treatment)	mg/ l MnO_4	na	4,44				
Phosphorus	mg/l as P	na	<0.15				
Sodium	mg/ l as NaCl	<350	2,15				
Sulfate	mg/l as So_4^{-2}	<250	ND				
Bicarbonate Alkalinity	mg/l as CaCO3	na	45,8				
Chemical Oxygen Demand	mg/l	na	<40				
Chloride (residual of treatment)	mg/l as Cl	<0.2	<5	ND	ND		
Conductivity	10-6 S/cm	<1000	31,9			132,9	
Hardness	mg/l as $CaCO_3$	300	30	77,8	25,9	132,9	82
M – Alkalinity	mg/l as $CaCO_3$	na	46				
pH		6 to 8	7,6			7,3	
Total Dissolved Solids	mg/l	600	82				
Turbidity	NTU	<10	18,54	110	25	108	9,25

Annex VII.
Rainwater Harvesting from Roofs in High Density Areas

RAINWATER HARVESTING | Roof Area - High Density Areas

Rainfall - Xam Neua, Laos (2002-2020)



Resource: Graph Produced by ITT, based on percipitation data from Xam Neua

Rainfall - Xam Neua, Laos (2002-2020)

Months	Median Percipitation (mm)
January	6.6
February	2.2
March	29.7
April	96.8
May	122.0
June	136.4
July	268.1
August	249.1
September	135.3
October	52.8
November	8.9
December	3
Total	**1110.9**

Sample Block Calculations

Block Location

PARAMETERS

Rainwater harvesting | Roof area	6,726 m²
Rainwater runoff | Block area	12,464 m²
Block density	0.54
Annual precipitation in	1111 mm/year

Water Collection Capacities

RAINWATER:How much service water can we collect annually on average?

Roof area | total		Annual precipitation		Run-off coefficient	Total production
6726	m²	1.111	m	0.9	6,716 m³
					8,716,000 liter

RESULT

Rainwater challenges

Increased load on infrastructure system, drainage and lack of space for potential development and improvement. Flooding may occur during rainfall events. Given the quality and conditions of housing, flooding may further deteriorate the physical condition of housing as well as conditions in the area.

Rainwater opportunites

High number of the roof surfaces can provide a great opportunity for water collection - the calculations above show, how much water could be collected, based on exemplary block of settlements with high density. If water could be collected from all houses, during one year 8, 716, 000 liters of water could be harvested.

Figure 106. Rainwater Harvesting Calculations

Source: calculations done by (TUB, 2022)

*Selected high-density area – selected area with higher density in comparison to other identified types of settlements in Sam Neua

Annex VIII.
Estimated Annual Wastewater Discharged in Sam Neua

Villages	No. of House	Population	Discharge* (cu.m./year)
Misouk	246	1,126	32,879
ນາທອງ Nathong	287	1,407	41,084
ນາວຽງ Navieng	244	1,094	31,945
ນາໜອງບົວ Nanongbua	249	1,282	37,434
ນາທົ່ງຈອງ Nathongjong	237	1,246	36,383
ພັນໄຊ Phunxay	294	1,620	47,304
ທາດເມືອງ Thatmueang	597	3,242	94,666
ໂພໄຊ Phoxay	310	1,509	44,063
ນາສະການ Nasakarn	303	1,564	45,669
ໂພນຄຳ Phonekham	122	778	22,718
ຊຳເໜືອ Samneua	412	2,021	59,013
ນາລີ Naliew	248	1,508	44,034
Total	**3,549**	**18,397**	**537,192**

* Estimated wastewater discharged 80l/capita/day

Table 5. Estimated Annual Wastewater Discharged in Sam Neua (AIT & BORDA, 2022)

Source: (AIT & BORDA, 2022)

Annex IX.
Estimated Annual Faecal Sludge Accumulation in Sam Neua

Villages	No. of House	Population	Annual Sludge Accumulated (cu.m./year)[1]		Annual Sludge Accumulated (cu.m./year)[2]	
			WHO*	WHO**	SNV*	SNV**
ມີສຸກ Misouk	246	1,126	45	68	123.9	90.1
ນາທອງ Nathong	287	1,407	56	84	154.8	112.6
ນາວຽງ Navieng	244	1,094	44	66	120.3	87.5
ນາໜອງບົວ Nanongbua	249	1,282	51	77	141.0	102.6
ນາທົ່ງຈອງ Nathongjong	237	1,246	50	75	137.1	99.7
ພັນໄຊ Phunxay	294	1,620	65	97	178.2	129.6
ທາດເມືອງ Thatmueang	597	3,242	130	195	356.6	259.4
ໂພໄຊ Phoxay	310	1,509	60	91	166.0	120.7
ນາສະກາງ Nasakarn	303	1,564	63	94	172.0	125.1
ໂພນຄຳ Phonekham	122	778	31	47	85.6	62.2
ຊຳເໜືອ Samneua	412	2,021	81	121	222.3	161.7
ນາລີວ Naliew	248	1,508	60	90	165.9	120.6
Total	**3,549**	**18,397**	**736**	**1104**	**2,023.7**	**1,471.8**

1 WHO*:40 litres/capita/year for excreta retained in water where degradable anal cleaning materials are used; WHO**: 60 litres/capita/year for excreta retained in water where non-degradable anal cleaning materials are used; SNV*: 0.11 cu.m./capita/year in Viet Nam; SNV** 0.08 cu.m./capita/year in Cambodia

2 SNV*: 0.11 cu.m./capita/year in Viet Nam; SNV** 0.08 cu.m./capita/year in Cambodia

Table 6. Estimated Annual Faecal Sludge Accumulation in Sam Neua (AIT & BORDA, 2022)

Source: (AIT & BORDA, 2022)

Annex X.
National Environment Standards 2017 – Standards for Controlling Water Pollution from Toilets

Parameters	Symbol	Standard	Unit	Method of Exmanination
Potential of Hydrogen	pH	06_09	-	pH Meter
Biological Oxygen Demand 5 days	BOD5	30	mg/L	Azide Modification at 20°C, 5 days
Chemical Oxygen Demand	COD	125	mg/L	Potassium Dichomate Disgestion, Open Reflux or Closed Reflux
Total Suspended Solid	TSS	50	mg/L	Glass Fiber Filter Dise
Total Nitrogen	TKN	10	mg/L	Kjeldahl
Phenol	C6H5OH	2	mg/L	Distillation and Aminoantipyrine Method 4
Fat, Oil, and Grease	FOG	5	mg/L	Solvent Extraction by Weight
Total Dissolved Solid	TDS	400	MPN/ml	Dry Evaporation 103-105 20°C, 1 hou7

Table 7. Standards for Controlling Water Pollution from Toilets

Source: (National Environment Standards 2017)

Annex XI.
National Environment Standards 2017 – Standards for Water Pollution Control from General Industries

Table 8. Standards for Water Pollution Control from General Industries

Source: (National Environment Standards 2017)

Parameters	Symbol	Standard	Unit	Method of Examination
Potential of Hydrogen	pH	06_8.5	–	pH Meter
Total Dissolved Solid	TDS	≤2500	mg/L	Dry Evaporation 103–105 20°C, 1 hour
Total Suspended Solid	TSS	≤50	mg/L	Glass Fiber Filter Dise
Temperature	t	≤40	°C	Temperature Meter
Color and Oder	–	None	mg/L	Genral
Hydrogen Sulfide	H2S	≤1.0	mg/L	Titration
Cyanide	CN-	≤0.2	mg/L	Distillation and Pyridine Barbituric Acid
Fat, Oil, and grease	FOG	≤5.0	mg/L	Solvent Extraction by Weight
Formaldehyde	CH2O	≤1.0	mg/L	Spectrophotometry
Phenol	C6H5OH	≤1.1	mg/L	Distillation and Aminoantipyrine Method 4
Chlorine	Cl-	≤1.2	mg/L	Lodometric
Pesticide	–	None	mg/L	GC
Biological Oxygen Demand 5 Days	BOD5	≤30	mg/L	Azide Modification at 20°C, 5 days
Total Nitrogen	TKN	≤100	mg/L	Kjeldahl
Chemical Oxygen Demand	COD	≤120	mg/L	Potassium Dichomate Disgestion, Open Reflux or Closed Reflux
Heavy metals				
Zinc	Zn	≤5.0	mg/L	AA/AES; ICP
Chromium Hexavalent	Cr+6	≤0.25	mg/L	
Chromium Trivalent	Cr+3	≤0.75	mg/L	
Copper	Cu	≤2.0	mg/L	AA/AES; ICP
Cadium	Cd	≤0.03	mg/L	
Barium	Ba	≤1.0	mg/L	
Lead	Pb	≤0.2	mg/L	
Nickel	Ni	≤1.0	mg/L	
Manganese	Mn	≤5.0	mg/L	
Arsenic	As	≤0.25	mg/L	
Selenium	Se	≤0.02	mg/L	AA-Hybrid Generation or IPC
Mercury	Hg	≤0.005	mg/L	AA-Cold Vapour Technique

Annex XII.
DEWATS (Decentralized Water Treatment Systems)

The DEWATS at the Sam Neua Market has a daily wastewater flowrate of 31.3 m^3/day and is made out of a two-chamber settlement tank, followed by a four-chamber anaerobic baffled reactor and a two-chamber anaerobic- filter. The DEWATS has a treatment efficiency of 91% for the chemical oxygen demand (COD) and of 93% for the biological oxygen demand (BOD).

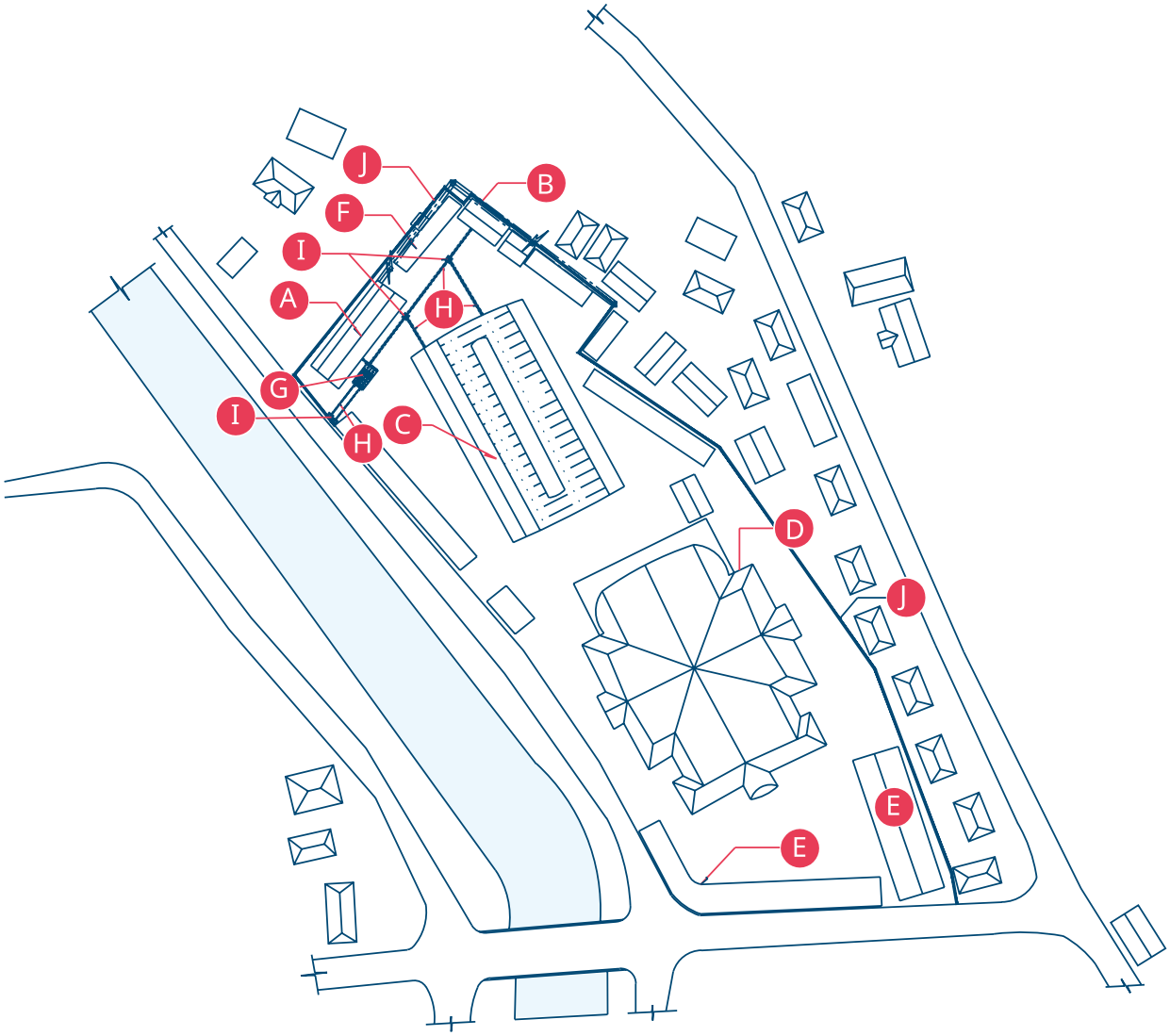


Figure 107. DEWATS situated at the Sam Neua market

Source: (Ministry of Agriculture and Forestry, n.D)

Legend

- **A** Meat shop
- **B** Toilets
- **C** Fresh market
- **D** Cloths and electronic services
- **E** Mobile phones and kitchen assets
- **F** Restaurant
- **G** DEWATS
- **H** Vegetable, fruits and rice shop
- **I** DEWATS pipeline
- **J** Wall

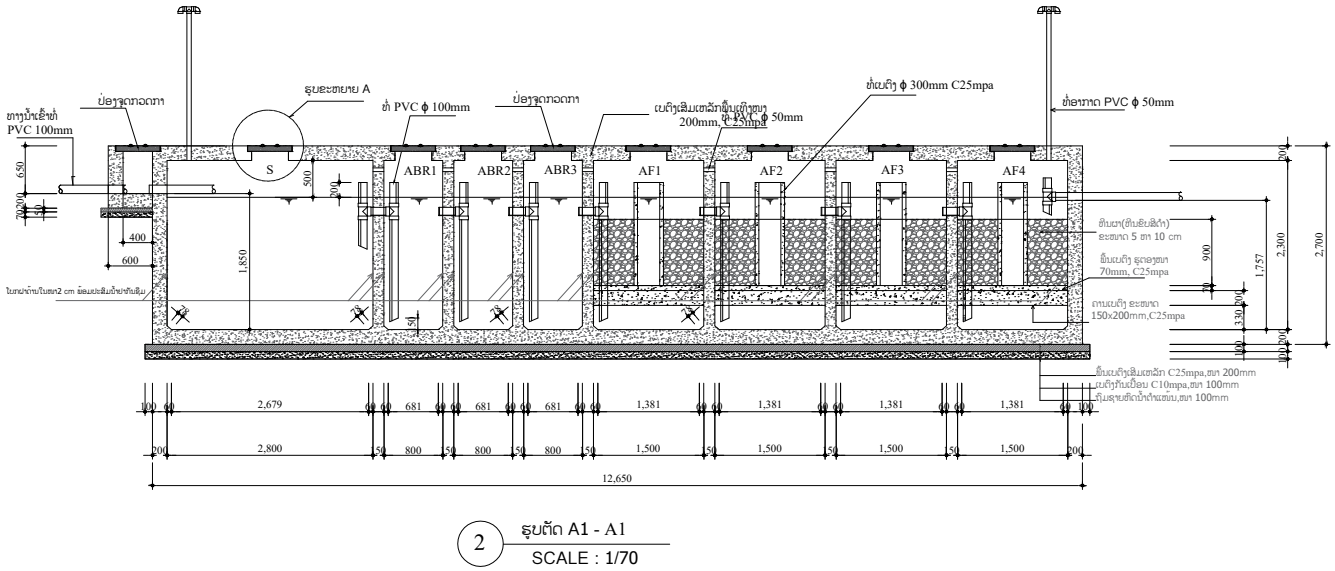


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Figure 108. Detailed plan of the DEWATS at Sam Neua Market

Source: (Ministry of Agriculture and Forestry, n.D.)

The man-holes illustrated in Figure 94 are shown in the photograph below in Figure 115.

In Na Vieng Village, the DEWATS serves a neighbourhood of 30 households – See Figure 96 for its location and Figure 114 for details of the design. The settlement tank reduces the water pollution by 25 %; the anaerobic baffled reactor reduces it by up to 75 % and the anaerobic filter reduces the pollution by up to 90 % (BORDA, 2015). The system has a capacity of 14 m^3 daily wastewater flow and consists of a two-chamber settlement tank (BOD removal of 28 %, COD removal of 26 %), followed by a baffled reactor with 4 tanks (BOD removal of 55 %, COD removal of 51 %) and a final anaerobic filter with 3 chambers (BOD removal of 57 %, COD removal of 53 %).

Figure 109. DEWATS in Sam Neua Market, man-holes on the Orad side

Source: (BORDA, 2021).

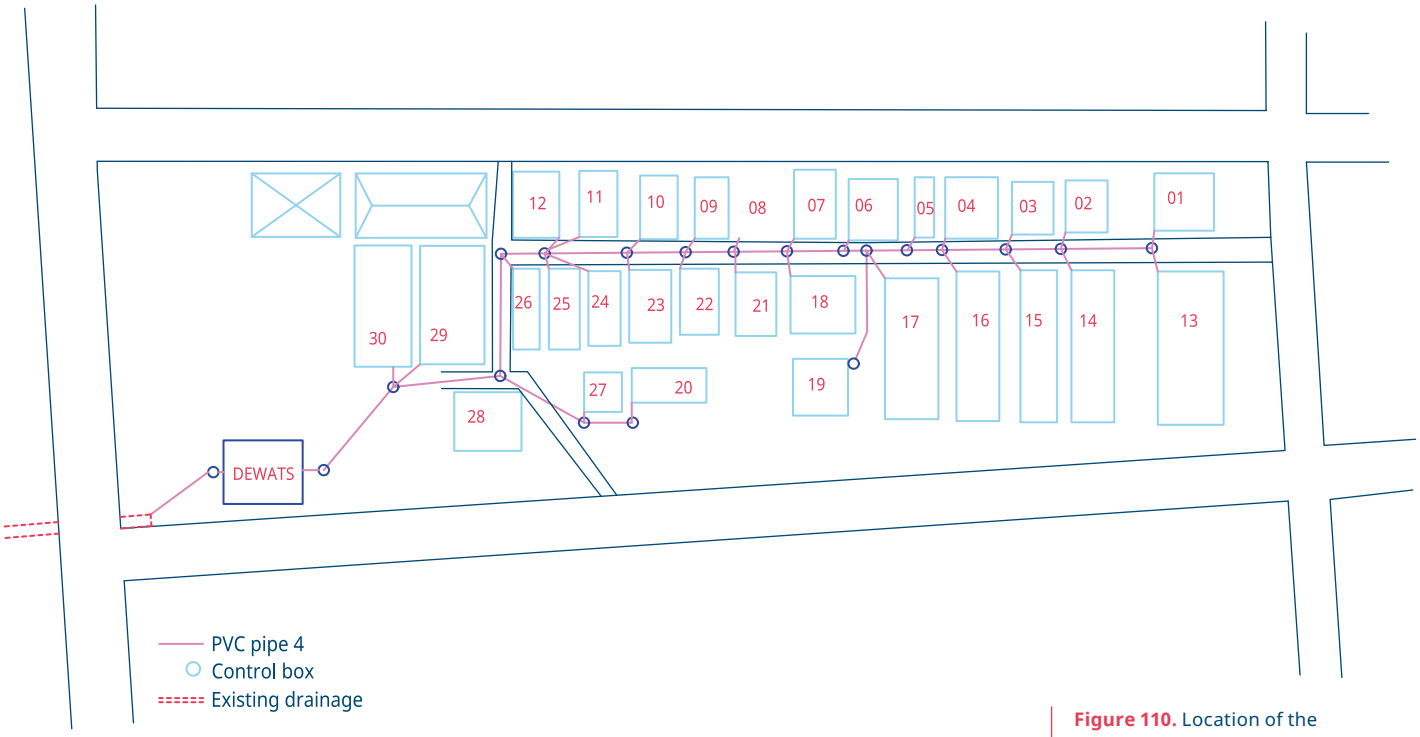

Figure 110. Location of the DEWATS in Na Vieng village
Source: (BORDA, 2015)

This DEWATS is a community-based sanitation project with the community owning and in charge of operating and maintaining it and the sanitation facilities within the village. Before the implementation of the project, most households used toilets with septic tanks and soak pits. These were unsealed in the bottom and rarely emptied suggesting significant blackwater infiltration into the ground. Untreated blackwater from pit latrines and household greywater was discharged into the local drainage system and the environment contributing to pollution of local water sources. To counter this environmental pollution, the household sanitation facilities were improved and a shallow sewage system with a secondary pipeline constructed connecting household pit latrines and greywater to the DEWATS (BORDA, 2015).

Figure 111. Detailed plan of the community DEWATS
Source: (BORDA, 2015)

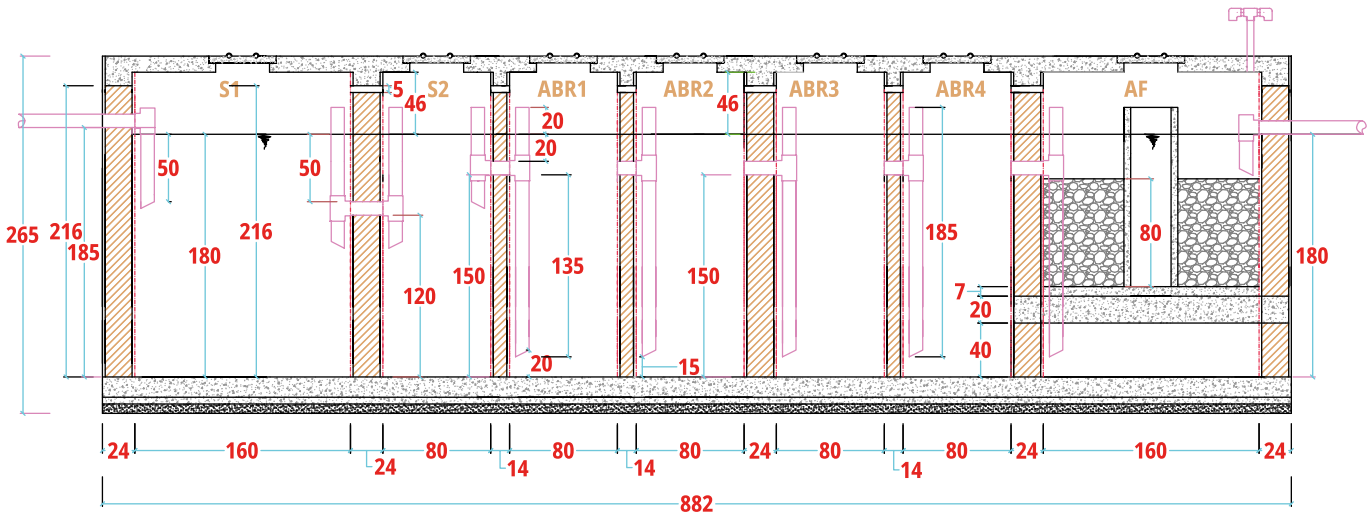

Figure 112. DEWATS construction
Source: (BORDA, 2015)

Figure 113. New sewerage pipeline
Source: (BORDA, 2015)

Annex XIII.
DEWATS Management Roles

The user community and the district, primarily the DPWT, manage the Navieng DEWATS and the work is reported to the departmental accountant. In case of problems, the district authorities are available to support the community.

CBS Committee (BORDA, 2015):

- Chairperson: Representations and ownership of DEWATS, contact person for arrangements & planning of meetings and support of project facilitation.
- Deputy Chair: Administration and secretarial tasks (communication and material preparation for meetings in assisting the Chairperson).
- Finance: financial matters including the collection of contribution fees, documentation and reporting

The DEWATS CBS aims to create sanitation awareness and a willingness to practice hygienic standards and involve the community in the O&M, construction, financial contributions, and education. The households display their willingness to pay the current price of the DEWATS service (PUW, 2019). All CBS actions are cooperatively planned, agreed upon and implemented with all relevant stakeholders (BORDA, 2015).

Annex XIV.
Detailed Design of a Septic Tank & Design of a Seepage Pit

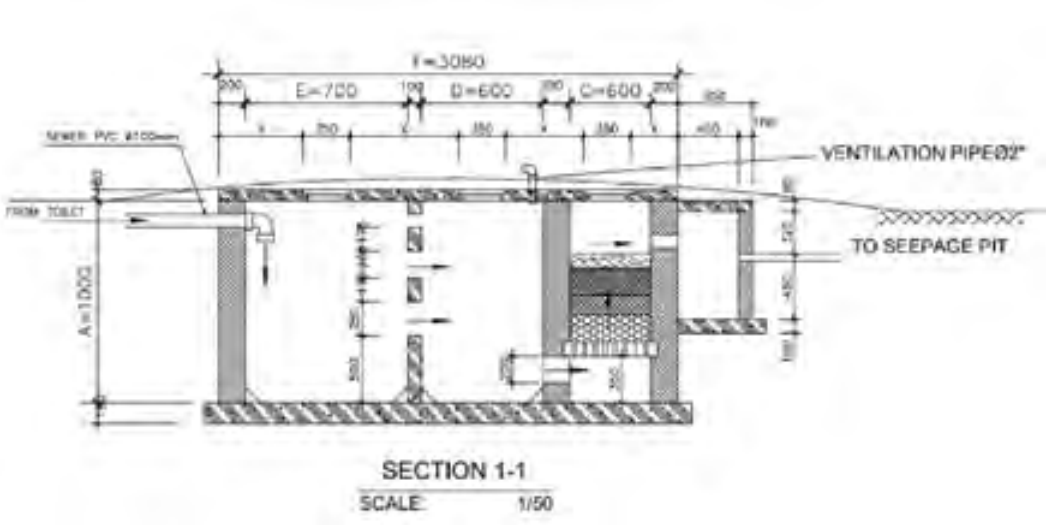

Figure 114. Detailed Design of a Septic Tank.

Source: (Department of Water Supply, 2017)

Figure 115. Example of a Seepage Pit

Source: (Department of Water Supply, 2017)

Annex XV.
Sam Neua UDAA Budget and Expenditure

Year	Budget			Comparison		% of Sanitation Budget (a+b+c)/(d)
	Waste-water (a)	Solid Waste (b)	Drainage (c)	Sanitation (a+b+c)	Averaged state & provincial budget* (d)	
2017	0	674,326,000	112,000,000	786,236,000	247,000,000,000	0.3%
2018	0	673,722,000	150,000,000	823,722,000		
2019	0	722,648,000	19,000,000	741,678,000		
2020	0	668,189,000	100,000,000	768,189,000		
2021	0	568,451,000	60,000,000	628,451,000		

Table 9. Sam Neua UDAA Budget and Expenditure
Source: (AIT & BORDA, 2022)

*The mission collected averaged state and provincial budget of Sam Neua from 2016 to 2020

Annex XVI.
Institutional Roles for Different Wastewater Treatment Tasks

Table 10. Institutional Roles for Different Wastewater Treatment Tasks

Source: (AIT & BORDA, 2022)

Institutional Roles for Different Tasks in Sanitation (as compiled by the four participants in institutional mapping) **Wastewater Treatment**		DPWT	UDAA	DONRE	Health	Agriculture	Private
Policy and strategy	System objectives (health, envt, sustainability, etc)			X			
Planning	Micro level functional requirements (septic tanks)	X					
	Macro level functional requirements (STPs)	X					
	Municipal treatment plan	X					
Asset management	System Inventory	X	X				
	Inspection of asset condition	X	X				
	Assessment of asset performance	X					
Development of infrastructure (incl. equipment)	Sewage Treatment Plants (STPs)					X	
	Pumps	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
	Community ST systems	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
	Septic tank cleaning and sludge removal						X
	Septic Sludge Treatment Facilities (IPLTs)	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
	Leaching fields, etc.						X
Operation & Maintenance	Sewage Treatment Plants (STPs)	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
	Pumps	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
	Community ST systems					X	
	Septic tank cleaning and sludge removal						X
	Septic Sludge Treatment Facilities (IPLTs)	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
	Leaching fields, etc.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Supporting activities	Promotion / public relations		X				
	Controlling environmental pollution			X			
Finance	Investment planning	X	X				
	O&M budget preparation and execution	X					
	Tariff setting		X				
	Tariff collection		X				

Annex XVII.
Institutional Roles for Different Drainage and Sewerage Tasks

Institutional Roles for Different Tasks in Sanitation (as interpreted from the interview) **Drainage and Sewerage**		DPWT	Health	DONRE	UDAA	Private	
Legend: L = leading, K = Coordinator, C = Consulting, S = Support							
Policy and Strategy	System objectives (health, envt, sustainability, etc)			X			
Planning	Functional system requirements	X					
	Municipal drainage & sewerage plan	X					
Asset management	System Inventory	X			X		
	Inspection of asset condition	X			X		
	Assessment of asset performance				X		
Development of infrastructure (incl. equipment)	Sewers	n.a.	n.a.	n.a.	n.a.	n.a.	
	Makro/Sub-makro River bodies	n.a.	n.a.	n.a.	n.a.	n.a.	
	Primary / Secondary drains (neighbourhood to river)	X			X		
	Tertiary drains (neighbourhood-level)					X	
	Pumps	n.a.	n.a.	n.a.	n.a.	n.a.	
Operation & Maintenance	Sewers	n.a.	n.a.	n.a.	n.a.	n.a.	
	Makro/Sub-makro River bodies	n.a.	n.a.	n.a.	n.a.	n.a.	
	Primary / Secondary drains (neighbourhood to river)				X		
	Tertiary drains (neighbourhood-level)					X	
	Pumps	n.a.	n.a.	n.a.	n.a.	n.a.	
Supporting activities	Promotion / public relations				X		
	Controlling environmental pollution			X			
Finance	Investment planning	X					
	O&M budget preparation and execution				X		
	Tariff setting				X		
	Tariff collection				X		

Table 11. Institutional Roles for Different Drainage and Sewerage Tasks

Source: (AIT & BORDA, 2022)

Annex XVIII.
Development Plan Framework

The Lao PDR Government practices a comprehensive planning and budgeting framework. The central government sets the national development priority and budget with the National Socio-Economic Development Plan (NSEDP) providing a 20-year strategy specifying targets and objectives for various sectors and regions. The current NSEDP has six outcomes: economic growth, quality human resources, enhanced wellbeing, environmental protection, regional integration and public governance and administration. The NSEDP is converted into a five-year and annual Public Investment Plan (PIP) listing the investment plans. Within this context, sector ministries develop their Ministerial Vision, Strategy and Action Plans (MVSAP) to align with the NSEDP goals and these are used as references for implementation. Currently, there is no formal cross-ministry mechanism for the coordinated implementation of the ministries' action plan.

Relationship Between Strategic Planning Documents

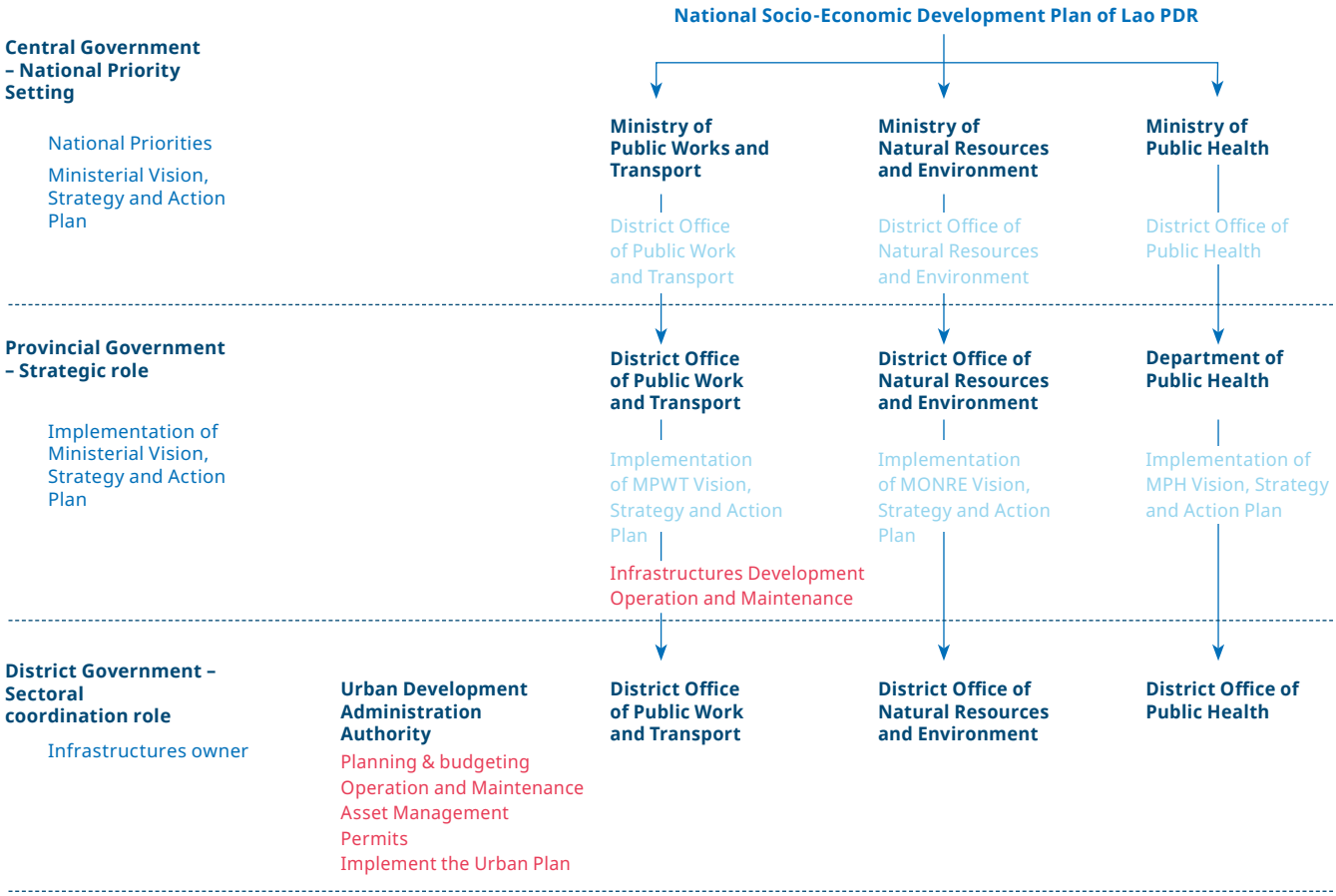

Figure 116. The relationship between strategic planning documents. The blue dashed lines represent coordinated efforts in setting up targets and action plans at the national level.

Provincial Governments' Strategic Role

The provincial DONRE is the host for the national environmental target, but it requires the active involvement of other departments to realise the goals. The provincial government is charged with formulating and implementing major goals and actions planned by the ministries. The MVSAP offers plenty of common or shared environment- and urban-relevant goals that require agencies to work together. For example, to achieve a Green, Clean and Beautiful Lao PDR, the MONRE has the target that water quantity and quality in ten river basins meets the national standards. This goal can only be achieved when wastewater from domestic, agricultural, industrial and services sources are managed and treated and the disposal of untreated wastewater to surface water is minimised.

District Governments' Sectoral Coordination Role

The district government does not have a framework to ensure coordination and cooperation across agencies. With a focus on the operational and maintenance of public infrastructures, the district authority ideally has control of the construction and use of private facilities, communicates a standard set of 'sanitation practices and codes' and engages the community to comply. These efforts consequently require the involvement of all district agencies, with direct or indirect interests in sanitation, urban development, and health, etc. Urban sanitation is a cross-cutting development issue in which every district agency plays a role.

Village Governments' Implementation Role

The villages are where the built infrastructures or projects are located and executed. The village administration maintains records of the existing facilities and other administrative records, such as population. The village administers permits for, among others, excavation and land filling, before submission to the UDAA or district office.

Provincial Annual Planning and Budgeting Process.

For the government budget, the province administrations manage the budget for its departments and the district administrations. This report uses DPWT as a showcase. DPWT forecasts plans and budgets for a fiscal year. It covers its activities. DPWT submits the forecast to the provincial planning and investment department who collates forecasts from other departments. The provincial's budget forecasts are then presented to the provincial governor for approval before submission to the Ministry of Planning and Investment (MPI). MPI collates forecasts from provincial governments and ministries and further submits to CPC. The National Assembly approves the forecasts following the budget and planning operational guidelines and considering the recurrent budget and allocation for the fiscal year. The Ministry of Finance takes responsibility to disburse the fund to the provinces and ministries once approved by the National Assembly. The fund to the provinces is transferred to the Provincial Finance Department which then be disbursed to DPWT and other provincial departments.

Depending on the project scale, DPWT presents the project, their plan and budget forecast to the Provincial Planning and Investment Department and the Provincial Governor. If the proposed project will cost more than five billion LAK, then DPWT shall present the project plan to the Ministry of Planning and Investment and secure approval from Parliament. The DPWT representative reported that the major projects in the past 3 to 5 years were road construction, improvement of water supply facility and network, and construction of government buildings. DPWT hands over built infrastructures to UDAA for operational and maintenance purposes. Administrative Structure for Urban Planning in Laos, Sam Neua.

Provincial Planning and Budgeting System

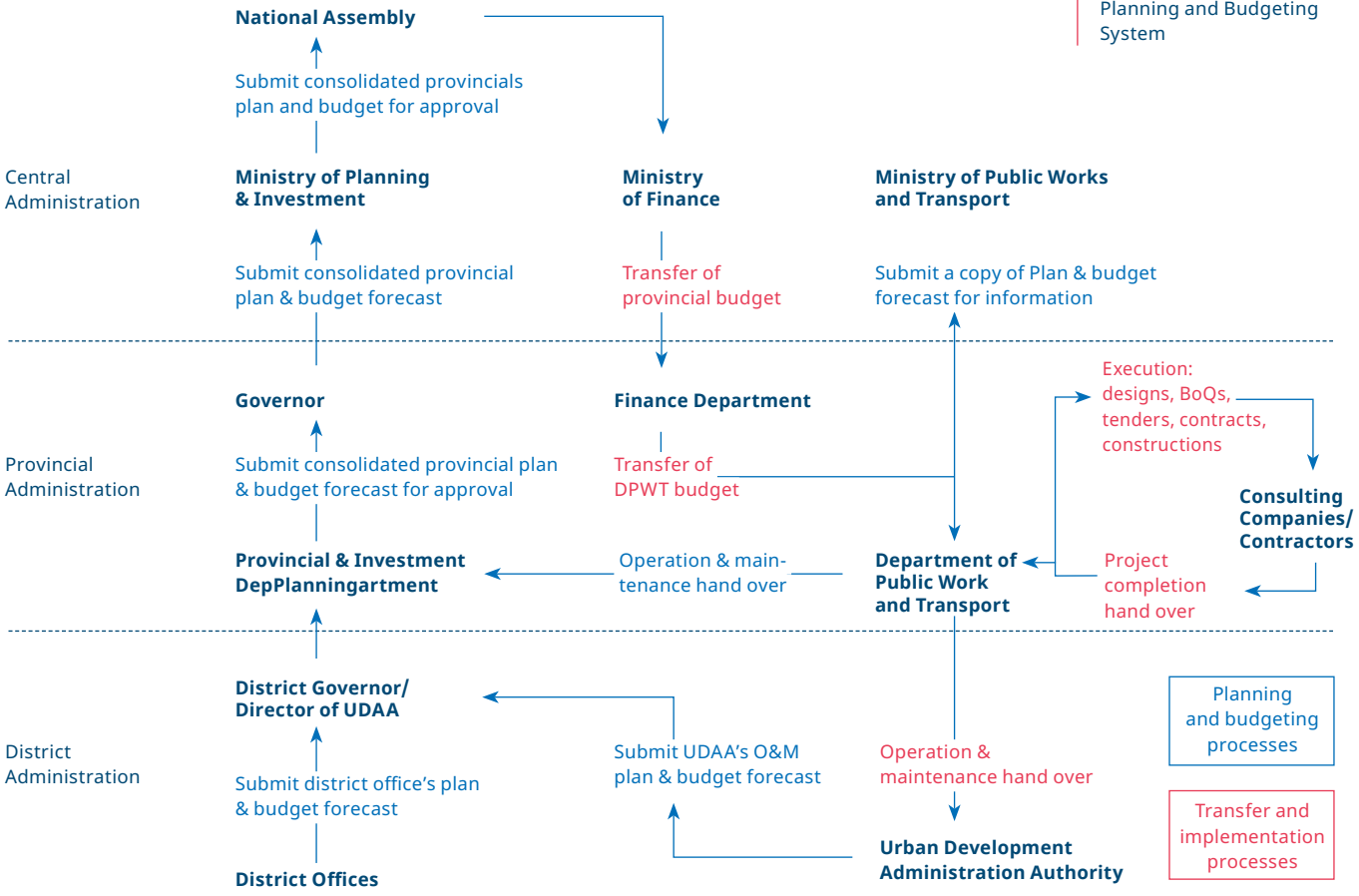

Figure 117. Provincial Planning and Budgeting System

Annex XIX.
Administrative structure for urban planning in Laos, Sam Neua

Administrative Structure for Urban Planning in Sam Neua

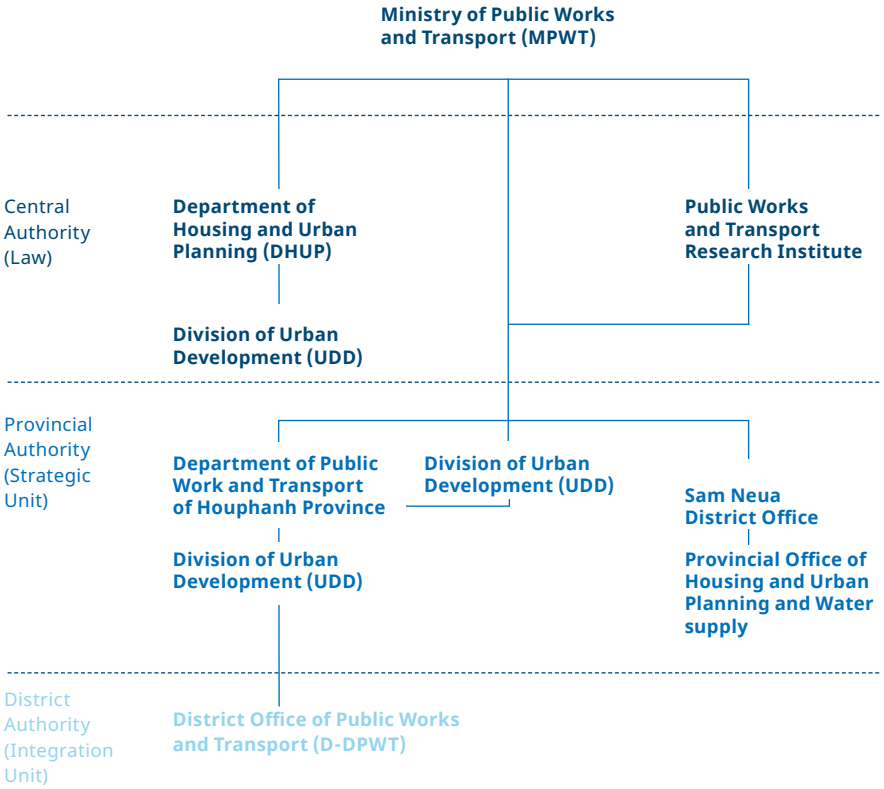

Figure 118. Administrative structure for urban planning in Laos, Sam Neua

Source: (TUB 2022, adapted from Vongpraseuth & Choi, p.792)

Annex X.
Green Indicators for Sam Neua (2022)

Chapter I:
Indicators for the Green Task

Article 7: Investment Activities
The investment activities are as followed:
All public and private investment activities must have a preliminary study on the impact as well as an environmental management and monitoring plan of the investment activity before signing the project concession agreement or starting any project. There must be an environmental certificate for the activity or the project from Provincial Department of Natural Resources and Environment, for the preliminary study report on the impact on the environment or from the District Natural Resources and Environment Office for environmental management and inspection.

Article 8: District Municipality
Indicators for district including various service facilities such as service facilities, tourist attractions, markets, airports, bus queues (stations), hospitals, hotels, guesthouses, restaurants, etc. are as follows:

- There are trees for providing the shades, tree giving the fruit, decorative or natural trees along the roads and public places within the municipality covering 20% of the area or more.
- There is at least 1 small public garden or flower garden with beautiful decoration
- Be the owner of saving energy and using resources effectively such as: the use of water, electricity and equipment in an economical manner, which has specific management and monitoring regulations

Article 9: Public and private offices
Indicators for public and private offices are as follows:

- There are trees to provide shade, fruit, and decoration covering 10% of the area
- There is at least one well-decorated flower garden, flower pot or lawn
- Be the owner of saving energy and using resources effectively such as: the use of water, electricity and equipment in an economical manner, which has specific management and monitoring regulations

Article 10: School
Indicators for schools are as follows:

- There are trees providing shades, trees giving fruit, and decoration covering 20% of the area
- There is at least 1 well-decorated flower garden, flower pot or lawn or more
- Be the owner of saving energy and using resources effectively such as: the use of water, electricity and equipment in an economical manner, which has specific management and monitoring regulations

Article 11: Village
Indicators for village are as follows:

- Designation to have 1 village reserve forest (according to the conditions of each village)
- There are trees providing shade, trees giving fruit, and decoration along the roads and small road covering 20% of the area.
- Households within the village must have a flower garden, flower pot or lawn that is beautiful decorated covering 80% of the households' number in the village.
- Be the owner of saving energy and using resources effectively such as: the use of water, electricity and equipment in an economical manner, which has specific management and monitoring regulations

Article 12: Households
Indicators for households are as followed:

- There are trees providing shade, giving fruit, and decoration covering at least 10% of the household area or more.
- There is at least 1 flower pot, flower garden, kitchen garden or lawn with beautiful decorationBe the owner of saving energy and using resources effectively such as: the use of water, electricity and equipment in an economical manner, which has specific management and monitoring regulations

Chapter II:
Indicators for clean task

Article 13: Investment activities
Indicators for investment activities are as follows:

- There are 1–2 garbage storage points
- There are trash bins separated by different types of waste according to each important points and according to the type of investment activity, such as: small size 3 points or above, medium size 5 points or above, and large size 10 points or above
- There is a sewage drainage system, stormwater and sewage treatment plant for 80 percent or more
- There are warning signs or prohibitions on maintaining the safety of employees, workers for 90 percent
- There is a standard toilet system and spring water system for 80% or more
- There is a gathered cleaning once a week regularly

Article 14: Municipalities and service facilities
Indicators for municipalities and service facilities such as tourist attractions, markets, airports, bus queues (stations), hospitals, hotels, guesthouses, restaurants, etc. are as follows:

- There is at least 1 waste disposal landfill in the district
- There is a place to put garbage bins or temporary garbage baskets to wait for transportation at least 2 points or according to the actual conditions
- There is a service to collect and transport garbage to the garbage disposal site regularly and according to the regulations
- 50 percent or more of garbage should have been separated
- Do not have dirty things such as: dust, garbage, wastewater, etc. for 80 percent or more
- There is a sewer system that drains into the public sewer, which is managed and cleaned regularly

Article 15: Public and private offices
Indicators for public and private offices are as followed:

- There is a collection point for the collecting of garbage as a system
- There is 100 percent waste separation
- There are 100 percent clean toilets
- Do not have dirty things such as: dust, garbage, wastewater, etc. for 90 percent or more
- The office must be allocated, managed and cleaned in a good order
- There is a sewer system that drains into the public sewer, which is managed and cleaned regularly

Article 16: Schools
Indicators for schools is as followed:

- There is a plan to implement the cleanliness of the school grounds such as: cutting the grass, collecting garbage, etc. on a regular basis
- There is garbage collection and 1 or more school garbage collection points
- There are enough trash cans in the classroom, school
- There are sewage and stormwater drainage system
- Teachers' offices and classrooms must be allocated, managed and cleaned in good order
- There are enough clean toilets
- There is 100 percent waste separation
- Do not have dirty things such as: dust, garbage, wastewater, etc. for 90 percent or more

Article 17: Village
Indicators for village is as follows:

- There is a garbage collection point in the village or in front of everyone's house as a system
- There is a shared toilet in the village or more
- There is management and cleaning the drainage canal regularly
- Do not have dirty things such as: garbage, wastewater, etc. for 90 percent or more
- Don't burn garbage on the side of the road, people's houses' ground or even spaces for 100 percent
- Animals should not be released in communities and public places to 90 percent

Article 18: Households
Indicators for households are as followed:

- There is a contract for the collection and separation of garbage with the UDAA or the garbage collection service unit
- There is a garbage can with a lid or a basket for storing garbage for households
- There is a sewage system with regular management and cleaning
- Must clean and maintain the cleanliness of his/her own house and public areas within the scope of responsibilities on a regular basis
- Do not have dirty things such as: garbage, wastewater, etc. for 90 percent or more
- Don't burn garbage in house's area to 100 percent
- Animals should not be released in village and public places for 100 percent

Chapter III: Beautiful Task

Article 19: Development project
Indicators for development projects are as follows:

- There are decorations, trees, flowers inside the area, and the road of the project covering 80 percent of the area
- There is decoration of the lighting system and road lighting in the project area covering 70 percent of the area
- There is a parking place for employees and guests as a system and there is 1 point or more
- There are banners and slogans related to the project with 3 or more points
- Decoration, decoration of buildings and places for 90 percent of the area
- Excavation, drilling and filling of soil must be approved by the relevant parts of the state before it can be implemented

Article 20: municipality of district and other places
Municipality and various places that include various service facilities such as service facilities, tourist attractions, markets, airports, bus queue (station), hospitals, hotels, guesthouses, restaurants, etc. are as follows:

- Allocating, decorations and decorating trees, parks, flower gardens, flower pots, lawns, roadside flowers, and roads in a good order
- Allotment of service shops nicely and in a good order
- Be the owner for maintaining cleanliness and protecting the environment within the city as normally
- Participation and contribution in the creation of various processes or activities of the district and on the important days of the nation as well as the Party on a regular basis

Article 21: Public and private sectors' offices
Indicators for the public and private sectors' offices are as followed:

- Allocating, decorations and decorating the trees, parks, flower gardens, flower pots, lawns, garden, office's wall and fence for 90 percent
- Be the owner for maintaining cleanliness and protecting the environment within the office as normally
- Participation and contribution in the creation of various processes or activities of the office and the important days of the nation on a regular basis

Article 22: School
Indicators for school are as below:

- Allocating, decorations and decorating the trees, parks, flower gardens, flower pots, garden, wall and fence of the school in a good order
- Be the owner for maintaining cleanliness and protecting the environment within the school as normally
- Participation and contribution in the creation of various processes or activities of the school and the important days of the nation on a regular basis

Article 23: Village
Indicators for village are as below:

- Allocating, decorations and decorating the trees, flower gardens, flower pots, lawn in a good order
- Be the owner for maintaining cleanliness and protecting the environment within the village as normally
- Participation and contribution in the creation of various processes or activities of the village and the important days of the nation on a regular basis

Article 24: Household
Indicators for household are as below:

- Allocating, decorations and decorating the trees, parks, flower gardens, flower pots, ground, garden, wall and fence of the household in a good order
- Be the owner for maintaining cleanliness and protecting the environment within the household as normally
- Be the owner for contribution in the creation of various processes or activities of the village and the important days of the nation on a regular basis

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Profile of PolyUrbanWaters

PolyUrbanWaters is a research and project network funded by the German Federal Ministry of Education and Research (BMBF) that consists of academic institutions, municipalities, local and national government agencies, civil society and private-sector stakeholders from Indonesia, Cambodia, Laos, Thailand, Vietnam and Germany.

PolyUrbanWaters responds to the strong need to generate deeper, transferable and scalable know-how for the effective localization of polycentric approaches to urban water resources management in secondary and tertiary cities of the SEA region.

The project intends to demonstrate the importance of polycentric approaches to the management of urban water resources, contributing to the water-sensitive transformation of secondary and tertiary cities in SEA towards resilient, inclusive and livable urban areas, thus contributing to the fulfillment of national and global sustainability agendas.

In order to do this, the project will elaborate an empirically proven conceptual framework for these approaches with: a) development of relevant instruments for its implementation and scalability; and b) a sustainable contribution to the systematic emergence of a new interdisciplinary practice-oriented research and economic-academic cooperation context.

The PolyUrbanWaters international research collaboration focuses its research activities around three Living Labs located in Sleman (Indonesia), Sam Neua (Laos) and Kratié (Cambodia), which provide a representative cross-section of the challenges faced by fast-growing secondary and tertiary cities in the SEA region in diverse governance contexts.

Within this framing, PolyUrbanWaters pursues the following core questions:

1. How can a diverse set of stakeholders contribute to building an inter- and transdisciplinary local knowledge base on water and urban development-related challenges in the SEA region? How can this knowledge be systematized, scaled and regularly updated to serve as a basis for inclusive and future-oriented municipal planning approaches across the region?

2. How can effective and sustainable water-sensitive urban development be fostered through a combination of centralized and decentralized technical and social-ecological innovations – including nature-based solutions, participatory strategic planning and effective water management structures – as an integral part of a systemic polycentric nexus approach (water, waste, energy, housing, IT, food, community development, etc.) and innovative financing schemes for the management of urban waters?

3. How can “water” serve as a strategic entry point to integrated, inclusive and resilient urban development that is guided by the SDG framework? Which polycentric, intersectoral and participatory governance approaches are required to plan, develop, sustainably operate and finance integrated, water-sensitive development with the capacity to evolve further in line with dynamic urbanization processes?

4. How can local innovation processes inform new practice-oriented pedagogies, capacity building approaches and research agendas to strengthen a network of academic institutions in the region?

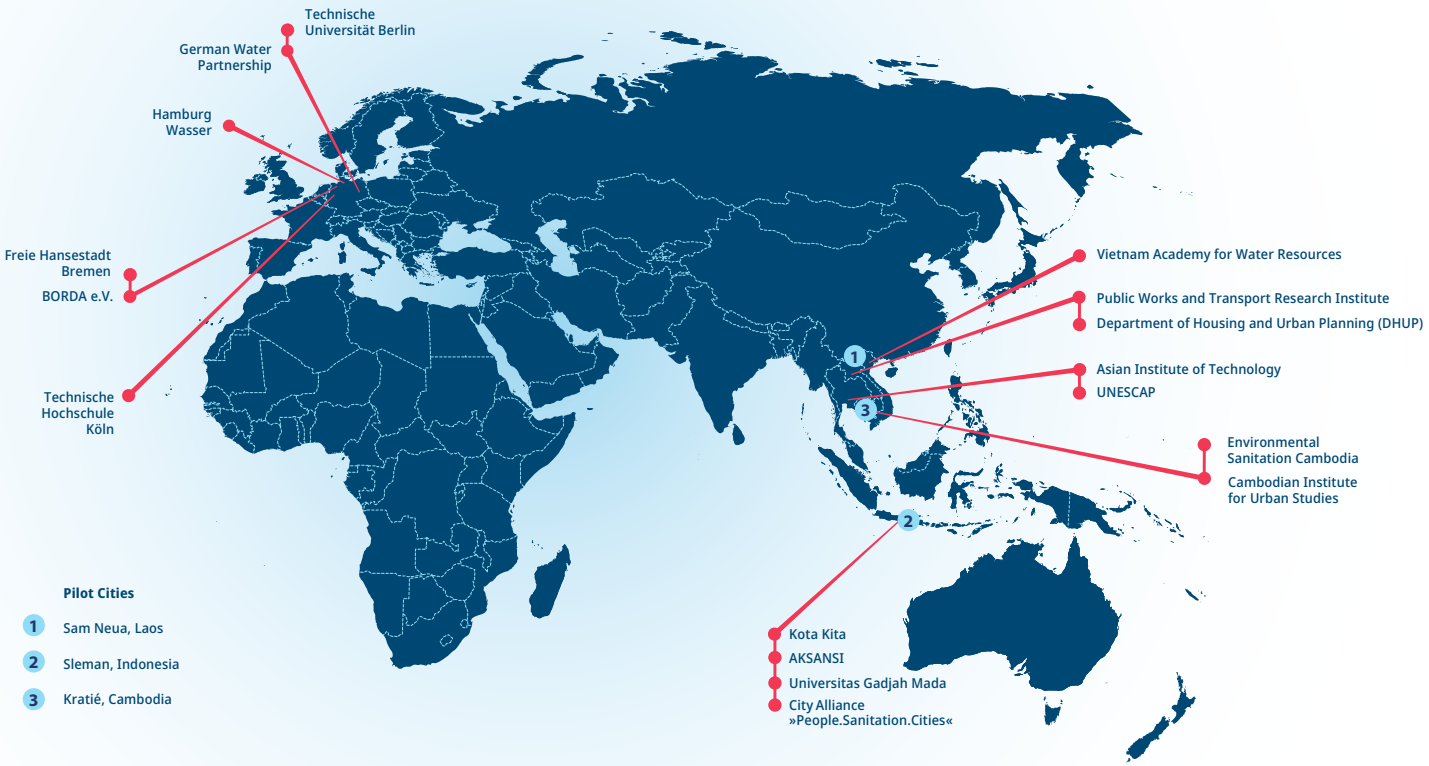

Figure 119. The PolyUrbanWaters-Partnernetwork and Pilot Cities

Notes:

Sam Neua town is transforming into land-linked provincial capital. The challenges for achieving its vision of a green, clean and beautiful town are increasing with its urban growth and changes in the water catchment. By effectively addressing these issues, polycentric approaches to the management of urban waters may help the town to develop its sustainable vision by localizing the Sustainable Development Goals.

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