

1. Project Summary

While global agendas such as the Sustainable Development Goals (SDGs) or the New Urban Agenda (NUA) have outlined holistic visions of sustainable futures for urban areas, there remains a strong need to generate deeper, transferable and scalable knowledge and know-how for their effective localization. A key challenge is to overcome sectoral fragmentation at national and local governance levels to ensure more integrated and inclusive approaches for transitioning urban spaces to sustainability. This is especially applicable to the critical gap at the juncture between urban water management and urban planning. The applied research project Polyurbwater addresses this gap by exploring the multiple interlinkages between both sectors and by developing concepts and tools for planning and governance approaches for fast growing, secondary and tertiary cities Southeast Asia (SEA), a region that remains under-researched (Roberts, 2014; Danieri et al., 2020). The results from the project's Definition Phase confirmed the particular relevance of the nexus between water management and urban planning as well as the limitations of classical approaches towards infrastructure development and planning in comprehensively addressing social, economic and environmental vulnerabilities that will be drastically exacerbated by climate change. Based on the hypothesis that polycentric approaches to urban water management can address mismatches between needs and capacities of these cities, the research project Polyurbwater pursues the following 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 (NBS), 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.)?
3. How can “water” serve as a strategic entry point towards 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 such integrated water-sensitive development that has 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?

Polyurbwater is a project of an inter- and transdisciplinary research consortium of academic institutions, civil society organizations, public/government institutions, private sector actors and cities from Cambodia, Germany, Indonesia, Laos, Thailand and Vietnam. Polyurbwater focuses its research activities around three Living Labs located in Sleman (Indonesia), Sam Neua (Laos) and Kratie (Cambodia), which provide a representative cross-section of the challenges faced by fast-growing secondary and tertiary cities in SEA in diverse governance contexts. The research will develop and test innovative and transferable tools for inclusive, cross-sectoral decision-making for polycentric water-sensitive urban development and support its exemplary implementation. The project will develop a research and learning partnership across SEA and with Germany. Close cooperation with regional and multilateral organizations such as UNESCAP and German Water Partnership (GWP) will allow leveraging and scaling up of project results.

2. Problem Statement, Current Research & Development Gaps

Cities are growing hubs for innovation and economic activities. By 2030, 60% of the global population is projected to live in urban areas, with the cities of SEA among the fastest urbanizing areas worldwide (Esch et al., 2018). Here, urban water-related transitions have seen increasing mismatches between rapid urban growth and the required investment in infrastructure, services and environmental management (Dahiya, 2014), leading to a situation where multi-scaled water burdens are being experienced simultaneously (Marcotullio, 2007). Rapid and frequently unplanned developments in many secondary and tertiary cities in SEA lead to the destruction of (aquatic) ecosystems, water pollution and the disruption of water cycles (Costa et al., 2016; Furlong and Kooy, 2017; Hoekstra et al., 2018). Climate change impacts (i.e., more frequent and intense floods and droughts) will further deplete freshwater sources, cause degradation of marine and estuarine environments (Costa et al., 2016; Furlong and Kooy, 2017). Rapid and frequently unplanned urbanization significantly accelerates supply gaps in water-related municipal public services and the overexploitation of water resources has reached alarming levels in many contexts (World Bank Group, 2016; ADB, 2018; UNESCAP, 2019). Because planning frameworks are often highly centralized, sectoral and designed to fit within ideal typical planning cycles, they are unable to capture the complex and fast changing interface between water management and urban development needs and address long-term changes.

While global agendas such as SDGs or NUA offer some orientation towards a holistic vision, key obstacles are a lacking knowledge base that connects a deep local understanding of current challenges and available resources as well as cross-sectoral processes, tools and capacities to plan and steer effective transformation (Gutterer and Reuter, 2016). Polyurbwater seeks to develop tools and frameworks for cross-sectoral cooperation that bridge existing silo approaches by bringing together different sectors and relevant stakeholders, such as public entities, private sector, communities, civil society and academia. Most integrated solutions are not solely technical but rely heavily on both social-ecological and governance dimensions as well as the strong participation of local stakeholders in planning processes as key drivers of change. Polyurbwater integrates this transdisciplinarity by working with a diverse team collaborating with state and non-state actors, thus increasing the chances of securing sustainable gains (e.g., Ostrom 1996; Watson 2014; Huchezmeyer & Misselwitz 2016). Effective responses to current challenges require the ability to first acknowledge and then integrate a multiplicity of predicaments that prevent positive and sustainable transitions. This multiplicity crystallizes in cities, where various stakeholders have to generate synergies and understand trade-offs between ecological, social and political transformation to anchor water-sensitive development and climate action. The greatest challenge in being able to achieve this aim is often not technology or capital, but rather a generation of knowledge, the integration of regulatory frameworks and the empowerment of practitioners with the right sensibilities, skills and conceptual agility to guide this transformation process. Large cities are hard-pressed to find and train staff with these capabilities; for secondary and tertiary cities in SEA this challenge is even more demanding (Sheng, 2010). A key sensitizing concept for the proposed research project is that of urban resilience, which has become widely used in research and development contexts (Meerow et al., 2016; Béné et al., 2018). “The great challenge of resilience is that it is still a relatively abstract concept to many decision-makers in SEA. Due to its multi-sectoral nature, resilience is still difficult to frame and relatively complex to understand how it differs from more classic public policy tools. In parallel, the concept suffers from the “catch-all syndrome”, by which resilience appears to cover every aspect of urban governance and as a result suffers from a paralysis whereby it ends up “covering nothing at all” (UNESCAP, 2019). With this in mind, Polyurbwater seeks to specify the concept of resilience by

translating it into tangible aspects of integrated water-sensitive urban planning in the specific context of secondary and tertiary cities in SEA. This will provide a framework to broaden water and sanitation specific concepts such as “integrated sanitation approaches” towards more comprehensive urban development models such as “water-sensitive cities”, “water wise cities” and “sponge cities” (Barron et al., 2017; Koop et al., 2017; Ren et al., 2017; Narain et al., 2018; BORDA SEA, 2018; 2020). Here, the project addresses research gaps concerning: water-related challenges (Furlong & Kooy, 2017; Aboelnga, Ribbe et al., 2019; Luo et al., 2019), climate change effects (Georgeson et al., 2016; Bai et al., 2018a), urban resilience (Ilgen et al., 2019; Spencer & Meng, 2019) as well as urban governance processes (Daniere et al., 2020) including the consideration of social ecological systems (Flynn & Davidson, 2016) and the more practice focused exploration of concepts such as “sponge cities”, where research is often limited to the megacities of the region. Secondary and tertiary cities struggle to obtain adequate support and often fail to attract long-term research into their specific conditions, resources and challenges despite shouldering the largest proportional share of urban growth (Marks, 2018; Tzu-Ling Chen et al., 2020). Birkmann et al. (2016) emphasize the need to boost water-related resilience of secondary and tertiary cities because they frequently struggle simultaneously with faster population growth, high vulnerability to climate change and environmental disasters, lower budgets and weaker institutional capacities. A further characteristic of local urbanization frontiers of such cities is the simultaneous presence of and hybridization between rural and urban lifestyles, rural and urban organizational forms and hierarchies including decision-making structures. In planning literature, this condition is often referred to as peri-urban or *desakota* (Mc Gee & Shaharudin, 2016). Scholarly research on the impact of this dynamically changing urbanization frontier on water systems and related practices and lifestyles remains underdeveloped.

A second sensitizing concept is the notion of polycentricity and polycentric approaches that the project seeks to apply to the management of urban waters. The idea of polycentric approaches builds on work from Ostrom et al. (1961), which has since evolved to describe a “complex form of governance with multiple centers of decision-making, each of which operates with some degree of autonomy” (Carlisle & Gruby, 2017). The NUA specifically calls for “integrated, polycentric” approaches that “strengthen the role of small and intermediate cities” (United Nations, 2017, pp. 24); however, without definition of how this vision could be operationalized. This project considers a water-sensitive polycentric approach to urban development to signify that multiple sectors work together with various local public and private stakeholder groups, integrating urban planning with water management using centralized and decentralized approaches. Such polycentric management of urban water resources needs to include the various meanings of water in its social, environmental and economic dimensions and therefore requires the inclusion of multiple stakeholder groups and the formulation of a collective water-sensitive vision that can be governed from multiple centers of responsibility (Neto, 2016; Narain et al., 2018; Bustillos, Evers & Ribbe, 2019). Here, Polyurbwater intends to co-create water-sensitive urban development scenarios with the pilot cities to foster urban resilience and strive towards the localization of the SDGs.

Beyond the formulation of a water-sensitive vision, methods and tools are required that enable a long-term transition process towards water-sensitive and polycentric urban planning. Globally, numerous tools and methods aim to contribute to water-sensitive development, urban resilience and the implementation of the SDGs (Savic et al., 2016; Andersson et al., 2019; Lund et al., 2019; Rall et al., 2019). However, many of these solutions have been applied in regions with relatively low urban growth rates and static governance systems such as Europe, the USA and China, meaning that practice-oriented research for water-sensitive tools and methods for the realities in fast developing secondary cities of SEA is lacking (Hare et al., 2003; Nesshöver et al., 2016; Bai,

2018b; Dorst et al., 2019; Frantzeskaki, 2019; Keeler et al., 2019). To make use of existing knowledge while addressing this research gap, the project will study the potential of establishing hybrid solutions for urban water resources management that combine (existing) grey infrastructure with NBS, as promoted by Gutterer and Reuter (2016), Bai (2018b), Frantzeskaki (2019), and Dorst et al. (2019). Such solutions aim for multifunctionality of space (Nesshöver et al., 2016), which is of central importance in dense urban areas, and provide both ecosystem services and infrastructure services in urban settings (Albert et al., 2019). Polyurbwater will assess the potential of flexible and resilient combinations of green and grey infrastructure to adapt to complex system challenges and changing environments in secondary SEA cities in a cost effective and sustainable manner (Haase, 2015). In this context, small, low tech and nature-based approaches are becoming increasingly important as resilience practitioners recognize the lower costs associated with leveraging ecosystem services to protect cities against resource depletion and extreme weather events (Gutterer et al., 2012; UNESCAP, 2019).

A significant knowledge gap exists in how polycentric approaches at the city level in SEA can be shaped on technical, social-ecological and governance dimensions (Furlong & Kooy, 2017; Bai, 2018b) and how their development can be translated in regulatory frameworks and in institutional capacities (co-management & co-production) (Sheng, 2010). Accordingly, there is great need for instruction regarding what it can mean for secondary and tertiary cities in SEA to “break down silos” in terms of interdepartmental, inter-agency or cross-boundary cooperation and coproduction for policy formulation at national and local levels, for planning and implementation procedures, and for the design of co-productive water management schemes.

3. Research Findings of Definition Phase and Preliminary Activities

Empirical research findings

Empirical research was conducted in Cambodia, Indonesia, Laos, Thailand and Vietnam during the Definition Phase of the project. An overview of process steps, milestone achievements and results are available at <https://polyurbanwaters.org/updates/>. On-site field research and context studies were performed to characterize urban water resources and urban planning processes in the pilot cities as well as to identify suitable Living Labs in Kratie (Cambodia), Sam Neua (Laos) and Sleman (Indonesia). This work was supported and enabled through: scoping workshops in Sleman, Bangkok, Vientiane and Sam Neua (September 2019); problem and stakeholder analysis workshops in Phnom Penh, Kratie and Sleman (November 2019); field research in Sleman (December 2019), workshops with local government and project partners in Abu Dhabi (World Urban Forum 10, February 2020) and numerous teleconference calls. Primary outcomes of the Definition Phase are:

- Formulation of an overview and spatial understanding of the challenges, both current and expected, related to urban water resources in the three pilot cities. Data collection for water cycle assessments in the pilot cities/Living Labs (Working Package (WP) 2, WP 3 & WP 4 of Definition Phase, in collaboration with AIT, AKSANSI, CIUS, Hamburg Wasser, Ministry Bremen, Kota Kita, VAWR, see list of partner reports in Attachment 1).
- Identification and analysis of best practices for integrated and SDG-oriented urban water management and inclusive infrastructure planning; analysis and evaluation of co-production approaches between state actors, governmental agencies, water operators, communities, civil society institutions and the private sector in the context of current and expected urban transformation processes.
- Pre-assessment for the potential to shape polycentric (multifaceted) water infrastructure (hybrid-grey-green-blue) approaches (WP 3, in collaboration with AIT, Hamburg Wasser).

- In-depth analysis of organizational structures, mandates, policy approaches and policy gaps in local government (municipal and sub-municipal/village levels) across the three cities/Living Labs; identification of resources and capacities for the design and coordination of transformation processes; analysis of local decision-making structures in national governance structures and corresponding administrative procedures (WP 3, in collaboration with AIT, AKSANSI, Bremer Senatsverwaltung, CIUS, Hamburg Wasser, Kota Kita, UGM, UNESCAP).
- Analysis of the institutional and legal frameworks for the engagement of the private sector and market development in the dissemination of decentralized solutions for sustainable wastewater treatment infrastructure (WP 6, in collaboration with AIT, Hamburg Wasser, UGM, UNESCAP).
- In-depth stakeholder analysis and capacity needs assessment (WP 5, in collaboration with AIT, Kota Kita, Hamburg Wasser, VAWR, UGM).
- Preliminary assessment for development of academic network, existing learning programs, current institutional arrangements and need for practice-oriented research (WP 5 & WP 6, in collaboration with AIT, CIUS, UGM, VAWR).

Furthermore, cooperation frameworks with local governments were established and trust between the pilot city municipal representatives and project partners was built during the in-person meetings and international teleconferences, resulting in the signing of cooperation agreements (Lols attached).

The major research findings of Definition Phase that were common to the three case studies are:

- All national development plans that guide planning in the three partner cities call for SDG localization or for SDGs to be converted and implemented in a concrete urban development plan. In various forms, the cities have elaborated initial strategies to make their cities liveable, ecologically sustainable, economically efficient, inclusive and climate friendly. They have identified the comprehensive and effective management of urban water resources as a strategic element for this development.
- Mainstream urban planning and development models, such as the development and implementation of centrally planned and managed, technical infrastructure solutions are not sufficient to meet the changing dynamics of the urban areas.
- Various drivers and pressures related to urban water resources have contributed to a system where the partner cities struggle with the reliable provision of drinking water, are unable to effectively manage wastewater and stormwater, and are unable to cope with extreme weather events (e.g., droughts and floods).
- The municipal government structures have a limited capacity to actively shape urban transformation processes, which is reflected in the insufficient development of a management framework for urban water resources. Rapidly progressing land use changes and poor solid waste management leads to flooding of urban areas, the washing out of existing sewage systems and water quality issues, damaging both public infrastructure and private property as well as threatening public health (diarrhea, dengue, etc.).
- Financeability and sustainable maintenance of effective water-sensitive infrastructure overwhelm the partner cities. Due to a lack of sufficient capacities, mandates and financing instruments, public-sector institutions act reactively rather than proactively.
- Due to insufficient, inconsistent and fragmented regulatory frameworks and poorly coordinated mandates of public bodies, markets for decentralized systems are barely developed. Operating models for existing wastewater treatment systems (centralized/decentralized) struggle with poor performance due to weak maintenance structures, unclear responsibilities, inadequate law enforcement and inconsistent financing schemes.

- "Water-sensitive cities" or "water wise cities" may be adequate guiding concepts for the water relevant urban transformations of the cities. Despite this, the partner cities currently lack the perceptions, the institutional capacities, administrative procedures, planning tools and practices and financing schemes to adapt such multi-sectorial concepts in their realities.
- A high degree of flexibility, modularity and polycentricity must be a key feature of water-sensitive infrastructure development for such cities. There is increasing awareness among city managers that the UN principle of "progressive implementation" (evolving infrastructures) should guide infrastructure development. In reality, this principle must be adequately defined according to the local context, implemented and sustainably maintained; hence, there are only few precise ideas about this at the planning and decision-making levels of the partner cities.

The previous 12 months of work culminated in presentations and discussion of our project work with the local and national governments ([Sleman 17/6/2020](#), [Sam Neua 23/6/2020](#), [Kratie 9/7/2020](#)), who then acknowledged the potential of polycentric management of their urban waters towards the sustainable development of their cities. The cities approved the methodological approach of Living Labs as appropriate to gain comprehensive knowledge about "water" in their cities and develop strategic management approaches for a transition towards water-sensitive cities. The profile of Polyurbwater's interventions in the cities have been selected according to the following criteria: **a. Relevance to project objectives:** gain in scientific knowledge and potential for development of methods and tools; **b. Relevance to local needs** for such interventions, already voiced or demonstrated by residents/municipality; **c. Impact: level of value added** provided by the project. **d. Minimization of risks** for project implementation; **e. Institutional arrangements:** established, stable, open for collaboration; **f. Capacities:** manageable with available project resources; **g. Manageability** by local structures and partners. Considering the size, complexity and heterogeneity of the three cities, decisions were taken to elaborate a customized comprehensive approach for Kratie and Sam Neua at the overall city level and for Sleman at a local district level. The local government of Sleman suggested six sub-districts as potential Living Labs. After comprehensive assessments based on the aforementioned criteria,

three sub-districts were shortlisted. A decision on the final location of Living Labs in Sleman will be taken after local elections later in 2020.

4. Project Objectives and Approach

The overall project goal is defined as:

"Polycentric approaches to the management of urban water resources contribute 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."

The specific project goal is defined as:

"Elaboration of an empirically proven conceptual framework "polycentric approaches to the management of urban water resources for secondary and tertiary cities in SEA", 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."

As a practice-oriented research project, Polyurbwater will:

- Concretize and test the concept of "Polycentric Approaches to Urban Water Resource Management in SEA" through an exploratory research anchored in three Living Labs and **develop customizable tools (including exploring digital opportunities)** to become tangible and operational for scholars, decision-makers, professionals, private sector and civil society.
- Specify further the concept of **resilience** in a prominent field of development of secondary and tertiary cities so it becomes more tangible for decision-makers and scholars.
- Elaborate specific polycentric schemes for the sustainable management of urban waters in their technical, social, financial and governance dimensions (support city governments in formulating bankable projects).
- Generate a **scientific knowledge base** and knowledge transfer of the parameters and enabling environments needed for a polycentric, water-sensitive urban development as a lever for a transformation to sustainability at the municipal/local level.
- Support the **application of instruments and capacity building** that foster transformation processes at the local, national and SEA levels.

The transdisciplinary research approach meets demands for a "transformative science" (Haan, 2010; Schneidewind & Singer-Brodoski, 2014; Schneidewind et al., 2016; WBGU, 2016). By accompanying concrete urban transformation processes through Living Labs, transferable results from planning and implementation processes will guide urban areas on their path to sustainability and enable access to decision-making processes on multiple levels (Kraas et al., 2008; IIPCC, 2014). The focus areas of the Living Labs have populations of approximately 3,000 - 25,000, meaning that insights for similar situations in the region can be generated and transferable instruments will be developed. In terms of methodology, the Living Labs are structured as an "embedded multiple case design", according to which: a) the countries determine the context and the framework conditions; b) the cities represent the "case"; c) selected neighborhoods contain embedded analysis units (Yin, 2009: pp. 46); and d) "case" oriented capacity development involving the relevant

stakeholders can be organized.

Polyurbwater is underpinned by strategic capacity development that transfers knowledge while simultaneously spurring innovation and fostering intense exchanges on both a horizontal level (various sectors within a municipality) and a vertical level (neighborhood-municipality-national government). To support the development of systemic capacities in the region and strengthen the academic exchange between SEA and Germany, the academic partners will develop a practice-oriented capacity development scheme mainly intended for further education of professionals and students. The scheme will be organized in a modular format with learning units that follow a given format and can be exchanged between partners to serve multiple capacity building purposes. The instruments to be developed are predominantly based on municipal practice and developed in cooperation with municipal actors, hence research questions are addressed in the real environment with the actors on the ground. The innovation processes necessary for a transformation of municipal practice will occur during the project Implementation Phase. Other cities in all five countries participating in the project have expressed their interest in implementing these instruments. Although Living Labs and empirical surveys are not feasible without an intensive physical presence on site and regular meetings to maintain cooperative relationships, we plan to reduce air travel emissions by avoiding unnecessary trips in the instances where a virtual presence suffices, and our strong network of SEA partners will be empowered to manage the Living Labs when the German partners are not present.

4.1. Project Outcomes

Outcome 1: Build a qualitative and quantitative understanding of “water” within urban development dynamics: Instruments are co-developed with local partners and communities within *and through the three Living Labs to support secondary or tertiary cities in SEA and their stakeholders to analyze current water use patterns, water related vulnerabilities and the interrelations of urban development dynamics:*

1. Sleman (Indonesia): The analysis “*Water-Sensitive Communities in Sleman 2021*” addresses the impacts of rapid and partly unplanned urbanization processes on water-relevant services in sub-districts (Kecamatan/Desas), especially those located along rivers. The local government is interested in developing strategic instruments that

enable sustainable water resource management for water-sensitive neighborhood/community development. Sidoarum, Sariharjo and Sambirejo were identified as suitable Desas (villages) through the application of the assessment matrix mechanism.

2. Sam Neua (Laos): The analysis “*Water in Sam Neua*” responds to the interest of city administration and the national Ministry of Housing and Urban Planning (DUHP) to create a comprehensive understanding of the urban water cycle within the urban development dynamics, characterized by population growth in a context

of increasing seasonal water shortages. The city government will be supported to develop a future-oriented strategy for making water-sensitive urban development an integral part of Sam Neua's SDG-oriented vision of a "green, clean, peaceful and resilient city".

3. **Kratie (Cambodia):** The planned approach "*Kratie - Living With Water*" addresses the vulnerability of the city to seasonal floods and the insufficient provision of water relevant public services, which is exacerbated by urbanization processes. The local government has expressed interest in instruments of strategic urban planning that contribute to water security and increased flood resilience.

For each pilot city/sub district, the project will elaborate a comprehensive understanding of the water cycle within the context of the respective urban development dynamics, the heterogeneity of urban spaces and existing governance approaches. The subjects of this investigation are current management systems of urban water resources, water related public services, considering their strengths and institutional and socio-economic development challenges, current and emerging investment regimes of public and private sectors, sectoral mandates of public institutions relevant for water-sensitive urban development and the corresponding regulatory framework conditions. This will be framed by participatory and capacity-building processes with the aim of providing government authorities, community members, investors, municipal enterprises, civil society organizations and scientific institutions with science based decision-making support in connection with water-sensitive urban design.

Outcome 2: Develop tools and instruments for future-oriented strategic urban planning including urban visioning, scenario development and conceptualization of water related resilience: Instruments developed in the three Living Labs support secondary or tertiary cities in SEA to elaborate a concept of water-sensitive and resilient urban development based on the SDGs, which can help to guide cities in modelling alternative urban development scenarios and taking informed strategic decisions for near real-time urban transformation. With the elaboration and regular refinement of future development scenarios (including "business-as-usual" and various future-oriented planning scenarios: "*Water-sensitive communities in Sleman 2030/2045*", "*Water for the Future Sam Neua 2030/2045*" and "*Living with Water in Kratie 2030/2045*"), water-relevant urban development approaches can advance beyond single sector decision-making practices. Expected trends in urban development and patterns of water availability and water consumption will be reflected by a range of scenarios that are bounded by two extreme cases. The project will provide analysis and prognosis of options for unplanned

urban development into new areas vs. planned water-sensitive urban development (e.g., single use vs. multifunctional spaces, NBS for rainwater harvesting vs. no NBS; unregulated groundwater exploitation vs. regulated groundwater extraction; centralized versus decentralized wastewater/sanitation systems) and its impact on urban water resources. The vision building will foster a comprehensive understanding of development opportunities at a high urban decision-making levels and planning/budgetary support can be sought from relevant state institutions at provincial and national levels. The scenario building process will make use of cross-sectoral spatial and participative modelling for water-sensitive urban design. Responsibility clusters of relevant local stakeholders and options for effective co-management of water-sensitive settlement and infrastructure patterns will be identified and discussed with particular reference to necessary professionalization processes, establishment of robust business models and financial viability over time. Comparative life cycle (energy, CO₂ emissions) and analyses of different options will be elaborated. Business models for the sustainable management of identified options will be elaborated. Gender related issues at community level will be strongly incorporated.

Outcome 3: Design of strategic pilot projects provides cities with entry points for a systemic water-sensitive urban transformation. The project will test how planning processes can be translated into transformative action at selected sites. Relevant instruments to support these processes will be developed. Pilot projects will contain the technical configuration of green/blue infrastructures for new residential development areas, integrated approaches to decentralized wastewater/stormwater management with special consideration given to NBS and the design of water-sensitive public spaces. Governance schemes for effective urban transformation and sustainable management of pilot measures will benefit from the practical experiences of German partners (Bremer Senatsverwaltung, and Hamburg Wasser) as well as others. Deriving from the analytical work of scenario building and strategy development, the pilot projects will localize entry points to bring water-sensitive development into practice. Methodologically designed as learning and co-production processes, relevant stakeholders from local government, private investors, households and water operators will work on the polycentric technical, social, financial and governance configuration of the areas. The approach and methodology will support partner cities to elaborate bankable projects to be submitted to relevant financial

institutions. The project will enable support for exemplary projects that address vulnerabilities by responding to current and upcoming challenges in the cities, in the pilot cities in (e.g., follow-up project testing wastewater for COVID-19, thus facilitating containment measures).

Outcome 4: In its systemic approach, the project supports the emergence of new multi-stakeholder cooperation structures between local, national and SEA levels. In this manner, it contributes to the emergence of a new political, academic, professional cross-sectoral narrative and of a regulative-political environment that is crucial for water-sensitive urban development. The processes and results of Polyurbwater will be used to build a common narrative in the research network through multi-layered capacity building activities in the SEA region and will be fed into technical and political decision-making processes at national, regional and global levels. A structured approach to integrated data management will create incentives for collaboration between agencies and creating synergies through multiple uses of data as a basis for assessments, planning and scenario building. The results from the Living Labs and the overall research will be processed into concrete products in the form of guidelines and recommendations for action, which serve as a guide for the development of standards and regulatory frameworks, particularly for actors at the national level. Cooperation with UNESCAP will ensure leveraging of results at the regional level. In addition to co-productive work processes in the framework of the Living Labs, the project will support the development of cross-sectoral working relationships on the horizontal level between partner cities and ministries and on the vertical level from the cities to the respective national government level. Integrated in an exchange of experience between the participating actors in the SEA context, a culture of cooperation will be promoted, thus enabling paths for systemic innovation beyond usual operational procedures.

Outcome 5: A practice-oriented research network SEA-Germany on “polycentric management of urban water resources” has been developed that: (a) contributes substantially to the research field “water-sensitive urban development”; and (b) organizes sustainable practice-oriented capacity development. The cooperation between academia, the public sector, civil society and the private sector will contribute to new forms of practice-oriented research and capacity development of all involved academic partners. Innovative virtual formats for knowledge management and training/education will support processes of digitalization based intersectoral cooperation and capacity building in the national and SEA contexts. With its focus on research in Living Labs as well as its strong emphasis on multi-stakeholder approaches and capacity development measures in a network approach, the project will allow: UGM to develop its capacities as a regional research, academic advice and training hub for water-sensitive urban planning; AIT to strengthen its capacities as a regional hub for decentralized water-sensitive infrastructure solutions; CIUS, PWTRI and VAWR to establish their capacities as national institutes for academic advice and practice-oriented training; and TUB and ITT to extend their capacities related to urban research and water resources management in SEA. The institutionalization of practice-oriented capacity development formats will be supported in both the Research and Development (R&D) phase and the Implementation Phase of the project.

Outcome 6: Generation of positive stimuli for the intensification of economic/academic relationships between Germany and the SEA region in the field of water resources management and urban development. German entities from public administration and water utilities will contribute their expertise by developing customized strategies and instruments that strengthen the water-related resilience of the pilot cities.

Polyurbwater will facilitate a practice-oriented dialogue between the German water sector and SEA actors, including small and medium-sized enterprises (SMEs). In an exchange on an equal footing, factors such as regulatory, technical and financial requirements for the development of integrated water-intensive infrastructures will be systematically discussed.

4.2 Work Plan & Milestones R&D Phase

WP 1: Project Management, Project Coordination, Project Communication

BORDA will assume the role as lead coordinator for project activities across the consortium. The coordination will be organized through its headquarters in Bremen and its regional office in Bangkok, Thailand. Coordination on national levels will be organized through its national offices in Cambodia, Indonesia, and Laos. BORDA will ensure effective and efficient coordination between the various working processes, communication and dissemination of results to academic networks, multilateral and local organizations, government agencies and the broader public. BORDA will maintain a general oversight of project activities in Germany, Indonesia, Cambodia, Laos, Thailand

and Vietnam, monitoring the progress and milestones in all WPs, organizing continuous communication between the project partners and the coordination and follow-up of internal working meetings on national, regional and overall project levels. This also includes the coordination of local, national and regional conferences and symposia. BORDA will ensure communication and dissemination in the national languages Bahasa Indonesia, Khmer, Lao and partner management and the quality management of the whole research process as well as utilizing and building on existing and trusted relationships with government agencies at national and local levels. Liaising with and regularly reporting to the funding organization DLR/BMBF on strategic and financial questions concerning the overall project also forms part of this WP.

WP 2: Living Labs

This WP ensures effective conceptual, methodological and organizational coordination, configuration and implementation of the three Living Labs in Sleman, Kratie and Sam Neua. BORDA will ensure that there is a permanent communication and coordination with government agencies and non-governmental stakeholders in the partner cities. Moreover, BORDA will assure an effective involvement of scientists and expert partners in on-site missions, provision of infrastructure, coordination of scientific work processes with partners and local structures, including the facilitation of continuous data collection by local partners (see WP 3). This includes the organization and management of multi-stakeholder processes at local and national levels and ensuring continuous work processes, continuous information flow between partners and cities, the research team in Germany and inputs from BORDA's expert teams. The WP will include the preparation of regular reporting and dissemination of research progress and results at the level of the three Living Labs.

WP 3: Tools and Methods to Assess and Monitor Urban Water Resources

WP 3 focuses on the physical assessment of spatial and temporal characteristics of available resources, water quality parameters, water demand, the modelling of changes in water resources under different scenarios of urban development, water relevant infrastructure and climate change projections. Novel methodologies will be implemented that combine information from multiple sources (e.g., ground-based monitoring stations, government datasets, remotely sensed data, reanalysis products and climate projections) to optimize the understanding of spatial and temporal patterns related to water availability, demand and quality. After completion

of the characterization of urban water resources in the pilot cities both at the current point in time and under future development scenarios, the focus will shift to the physical assessment of the impact of planned interventions on these resources. Furthermore, this WP includes the establishment of assessment and monitoring systems for the pilot cities, including the use of ITT SmartSense prototypes (<http://itt-smartsense.info/>) to complement existing databases. Finally, the feasibility of implementing such low-cost monitoring systems in other secondary cities in the SEA region will be assessed.

WP 4 Options for Sustainable Water-Sensitive Infrastructure Development and Polycentric Water Management

To specify pathways for water-sensitive urban transformation of the partner cities, WP 4 focuses on the technical configuration of context-specific green/blue/hybrid infrastructure solutions and their sustainable management. This WP will assess the potential of customizable, flexible and resilient combinations of green, blue and grey infrastructure to adapt to complex system challenges and changing environments in secondary SEA cities in a cost effective and sustainable manner. This research is embedded in the study of social-ecological systems, which are understood by Polyurbwater as a collection of dynamic social, technological and geophysical components that co-evolve through interactions among stakeholders, institutions (local government, water operators, etc.) and water systems such as surface/source water, groundwater, wastewater, sanitation and stormwater. Firstly, existing water-related infrastructure and their associated governance and management systems will be assessed. Subsequently, the results of this assessment will be combined with assessment results from WP 3, WP 5 and WP 6 to underpin the vision building process with realistic technical, social, and economic information, which, in a further step, will support the co-creation of customizable transition pathways towards sustainable water-sensitive infrastructure and robust water governance schemes at the community and city level. A mixed methods approach, including spatial analyses, network analyses, participatory data collection, focus group discussions, and interactive simulation models will be used to pursue the objectives of WP 4. Special attention will be paid to gender related issues within the social-ecological systems and to the multifunctionality of space, which is essential in fast changing and dense urban environments.

WP 5: Participatory, Water-Sensitive Urban Planning

This WP will identify gaps and opportunities to enhance water-sensitive urban planning at micro-levels (village, neighborhoods) and investigate how the establishment of effective co-production models to produce equitable water-sensitive urban transformation can be supported. The WP will develop appropriate instruments to support participatory needs assessments and data collection, visioning and scenario building, as well as action planning and progress monitoring. The WP will investigate how embedded local knowledge and agency of non-state actors and local residents can be more firmly built into existing and new co-production approaches with state agencies and non-state actors. The WP builds on the understanding and appreciation of existing local governance and planning cultures and procedures at micro-municipal and sub-municipal that was developed during the Definition Phase. The WP will include an assessment of existing co-production models in the three Living Labs, as well as processes and procedures of citizen involvement across the three pilot cities, which represent a broad spectrum ranging from highly centralized (Kratie & Sam Neua) to decentralized (Sleman) planning cultures. Local, participatory planning cycles related to the challenges of urban waters will be analyzed and accompanied by regular workshops and focus group activities. The potential of ICT (Information and communications technology; multi-modal tools) to support sub-municipal, local planning cycles and enhance their effectiveness and inclusivity will be explored. Results will be channeled into a peer-to-peer (neighborhood-to-neighborhood) exchange and feedback loops with the aim to develop transferable knowledge captured in appropriately designed manuals and guidelines for water-sensitive urban planning at micro-levels. This process requires continuous testing and adaptation of integrated tools and will accompany all Living Labs. The WP will ensure effective interface with research processes at micro-level, especially those of WP 4.

WP 6: Future-Oriented Planning towards SDGs

WP 6 will be anchored at municipal and national government (micro-meso) levels in the three pilot cities and develop a critical understanding and appreciation of transformation challenges, conflicts and risks at the

intersection between water and urbanization, as well as local planning and governance cultures and their current effectiveness. The WP will address the critical gaps and opportunities identified in the Definition Phase: the strengths and weaknesses of current planning systems and procedures in: a) facilitating integrated, cross-sectoral strategies to address water-urbanization challenges; and b) preparing for and guiding effective transformation processes through strategic visioning and future-oriented scenario building to complement existing 4-5 year planning cycles. The WP will also explore how global development agenda (SDGs, NUA, etc.) can provide broader orientation and guidance to local planning solutions and strategies. In doing so, it will also take appreciative stock of the work and initiatives the municipalities have already undertaken towards project relevant SDGs in their local planning formats and practices, with assessment of implementation (realized and prognosis). The WP will include the organization of regular workshops and focus groups with government agencies, such as public works and urban planning departments, to engender and/or enhance vital cross-sectoral cooperation, collaboration and co-production processes. The WP will explore and test the development of tools and instruments, including ICT supported tools, that can help anchor integrated, future-oriented planning at the intersection between water and urbanization in regional and local planning agencies. Developed visions for 2030/2045 and concepts for water-sensitive urban planning will include effective interface with research processes, especially WP 3. Results and knowledge gained will inform the development of a transferable toolbox, manuals and guidelines that can be disseminated across the pilot cities, the regional SEA City Alliance and inform tailored training activities and peer-to-peer (city-to-city) exchange.

WP 7: Knowledge Management and Capacity Development in the Region

Beyond the capacity building measures in the Living Labs and based on the iterative learnings in pilot cities, an interdisciplinary and transdisciplinary capacity building program linked to ongoing research activities will be co-developed by the academic partners of the project team and anchored at local and regional academic institutions. It will consist of advanced academic training (8 weeks blended training (online/classroom) and modules within existing master courses, following a modular learning unit format that allows the multi-purpose use by all partners). Target groups of the programs are professionals (urban planners, technical engineers, social scientists, etc.) as well as new urban practitioners, future educators and researchers. Formats that integrate with existing master programs are learning units directly connected to the three Living Labs, which will enrich the existing Integrated Water Resources Management (IWRM) master program offered jointly by ITT and VAWR. Additionally, the

developed learning units on integrated urban water resources management and water-sensitive urban design will be made available as open educational resources (OER) and taught at TUB, UGM and AIT. The content of learning units will be designed in a progressive development process incorporating ongoing findings of the R&D Phase. In order to ensure high quality of practice-oriented training, the capacity development program will contain a train-the-trainers element for teachers and trainers. As a supportive element for effective knowledge management, data and information generated as result of the research or provided by stakeholders will be archived and made accessible for stakeholders, researchers, trainers/lecturers and learners/students in order to facilitate the research, development and knowledge transfer processes. Furthermore, data visualization and simple analysis tools will be provided through a web-based platform adhering to international data management standards. During the R&D Phase, the virtual training will be conducted using existing training platforms. The establishment of a more technically and methodologically sophisticated platform - managed by the academic partners in SEA – will be supported during the Implementation Phase. The WP will also foster network building and exchanges around pedagogies and practice-oriented research across the SEA region. International students will act as change agents at the interface between academia and practice and increase the potential for a sustainable research, education and innovation network with Germany.

WP 8: SEA-Wide Dissemination and Networking

WP 8 will build close working relationships between the core consortium members, academic partners and organizations and agencies with a regional and global impact such as UNESCAP as well as the City Alliance for Water. This network will provide external feedback (peer review) on research results and on how they can be scaled and transferred across the SEA region to inform policy and practice as well as research agendas of academic institutions. A key outcome will be the development of practice-oriented guidelines for municipalities and relevant national policy makers. The guidelines will reflect the extensive research of the project on polycentric water-sensitive urban development. The whole research process will be presented in a comprehensive scientific publication, in which the scientists, scholars and practice partners will be able to present their research results and experiences.

WP 9: Economic-Academic Cooperation and Policy Dialogue

This WP ensures support for political decision-making and the development of an urban policy narrative "polycentric management of urban water resources". The results of the project will be continuously and systematically introduced into international, topic-relevant political processes, and Polyurbwater will be actively involved in shaping these processes. Close cooperation and coordination with strategic partners such as UNESCAP, ADB, GIZ, and UN Habitat form an integral part of the project processes. In this context, support is also provided for the formulation of political decisions, which aspires to lead to international standardization procedures. The WP also will assure establishment of cooperative relationships with the private sector and the German water industry. The experience of the German water industry for the strengthening of innovative water management in SEA has been introduced into the Living Labs via Hamburg Wasser from the commencement of the Definition Phase and this contribution will continue within the framework of the dialogue events organized by Polyurbwater. The early involvement of SMEs and working relationships with local water operators will also create opportunities for connection to the German Water Partnership.

4.3. Overall Project Objective, Outcomes, Level, Outputs and Indicators of Polyurbwater (R&D Phase and Implementation Phase)

Overall Project Objective	Outcome	Level	Output (WPs)	Indicators
Polycentric approaches to the management of urban water resources contribute 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	1. Instruments, developed in three Living Labs, support secondary or tertiary cities in SEA and its stakeholders to analyze comprehensively the current water use patterns, water related vulnerabilities and the interrelations of urban development dynamics (baseline assessment).	Urban spaces / urban sub-district within the pilot cities (including national decision-making structures) in Indonesia, Laos and Cambodia	WP 2, 3, 4, 5, 6 <ul style="list-style-type: none">• Development and local implementation of three effective urban diagnostic, planning and monitoring systems that generate synergies and co-benefits between water management and urban development.• Tool for the analysis of urban water use patterns in the city as a whole and sub districts/communities in the context of the urban development patterns and changing environment (including climate change).• Tool for multi-criteria, interdisciplinary evaluation and vulnerability analysis of water use patterns, infrastructure performance, provision of basic needs services and ecosystem services within the urban water cycle.• Tool for (gap) analyses of existing urban water governance structures and water related co-production (public entities, water operators, communities, households, private investors) at city and community/neighborhood level.• Tool for identification of potential cross-sectoral management schemes for polycentric urban water management.• Tool for the management of qualitative and quantitative data and information and monitoring of water-sensitive transformation processes.• Tool for the utilization of digitization options in participatory needs assessment, implementation and management.	<ul style="list-style-type: none">• In each pilot city, at least 40 representatives of local stakeholders have actively participated in the elaboration of the baseline analysis (Source of verification: Memos of stakeholder consultation, workshops, virtual meetings)• In each pilot city, at least 20 representatives of local stakeholders are trained on elaborating baseline analysis (Source of verification: Documentation from training workshops)• After 2 years of project, local/national governments approve baseline study as relevant for management of urban water resources in partner cities (Source: Official communication)• After 4 years of project, at least 2 local government departments in each partner city have integrated a set of elaborated analytical tools in their planning processes (Source: Planning documents of pilot cities)
	2. Tools and instruments are developed for future-oriented strategic urban planning including urban visioning, scenario development and conceptualization of water related resilience, supporting secondary or tertiary cities in SEA to elaborate a concept of water-sensitive and resilient urban development based on the SDGs.	Urban spaces/urban sub-district within the pilot cities (including national decision-making structures) in Indonesia, Laos and Cambodia	WP 2, 3, 4, 5, 6 <ul style="list-style-type: none">• Tool for comprehensive cross-sectoral spatial modelling of water-sensitive urban design.• Tool for modeling of appropriate polycentric (multifaceted) water infrastructure (hybrid-grey-green-blue) with special consideration given to NBS. Focus is given to the incremental development over time (2021-2030-2045).• Tool for assessment of preparedness for water-sensitive development on community/neighborhood level• Tool for the modelling and design of co-management of water-sensitive settlement and infrastructure patterns (public entities, water operators, communities, household private sector).• Tool for conceptualization of an integrated urban adaptation strategy to climate change, which combines technical measures, building standards and planning guidelines, including open space and landscape planning.• Tool for the development and validation of needs-based financing forms and instruments for financing the restructuring of municipalities and securing their ability to act.• Tool for the establishment of a management system for the monitoring (including environmental, social, economic, financial indicators) of planned urban transformation processes.	<ul style="list-style-type: none">• In each pilot city, at least 40 representatives of local stakeholders (local government, communities, private sector, civil society) have actively participated in the vision building. (Source: Memos of stakeholder consultation, workshops virtual meetings).• In each pilot city, at least 20 representatives of local stakeholders are trained on elaborating vision building and scenario modelling (Source of verification: Documentation from training workshops)• After 2 years of the project, local/provincial governments of pilot cities confirm that vision is relevant for SDG process and planning procedures of the partner cities. (Source: Official communication)• In each partner city, at least 20 representatives of local government and other stakeholders have actively supported scenario development processes (Source: Memos of stakeholder consultation, workshops, virtual meetings).• After 4 years of project, in each pilot city at least 2 tools developed are used for urban development planning (Source: Planning documents of pilot cities)
	3. Strategic pilot projects provide cities with entry points for a systemic water-sensitive urban transformation.	Urban spaces/urban sub-district within the pilot cities (including national structures)	WP 2, 3, 4, 5, 6 <ul style="list-style-type: none">• Tool for configuration and implementation of strategic pilot projects for water-sensitive urban transformation• Tool for the design of models of co-production for water-sensitive transformation at neighborhood and community level.• Tool for the design for effective business models for co-production for water management at neighborhood and community level.• Tool for the design and implementation of a strategy for integrated polycentric wastewater strategy in peri-urban areas (including technical, social, financial parameters).	<ul style="list-style-type: none">• At least three exemplary strategic pilot projects have been designed by the project and their implementation is supported by the project (Source: Project documentation, documentation of partner cities).• 200 representatives of stakeholder groups in all partner cities have actively participated in the design and implementation process (Source: Project documentation)
	4. In its systemic approach, the project supports the emergence of new multi-stakeholder cooperation structures between local, national and SEA levels. In this manner, it contributes to the emergence of a new political, academic, professional cross-sectoral narrative and of a regulative-political environment that is crucial for water-sensitive urban development.	National level, SEA	WP 2, 3, 4, 5, 6, 7, 8 <ul style="list-style-type: none">• Continuous cooperation platform established.• Guideline “Baseline assessment for water-sensitive urban design for secondary and tertiary cities in SEA”.• Guideline “Vision Building, Scenario Development, Conceptualization of Resiliency and Implementation Strategies for SDG-oriented water-sensitive development of secondary and tertiary cities in SEA”.• Guideline “Process of development of tools & instruments for water-sensitive planning in SEA”• “Guideline “Design of Water-Sensitive Communities in SEA”.• “Guideline for polycentric integrated wastewater strategies for secondary/tertiary cities in SEA”.• “Guideline for strategic capacity building for polycentric management of urban water resources for secondary/ tertiary cities in SEA”.• Guideline “Selected standards and standard operational procedures for polycentric water-sensitive transformation for secondary/ tertiary cities in SEA”.• Essential findings and working results are discussed at platforms and working groups of UNESCAP.	<ul style="list-style-type: none">• 6 essential recommendations of the elaborated guidelines are reflected in strategic and planning documents of key stakeholders at national and SEA level (Source: Panning documents on national level and SEA context)• 2 essential findings are reflected in standardization guidelines of the region (Source: Guideline documentation)• Presentation of project results at least 5 international conferences (e.g., World Urban Forum, Stockholm Water Week, World Water Forum, regional conferences, etc.).
	5. A practice-oriented research network SEA-Germany, on “polycentric management of urban water resources” has been developed that: (a) contributes substantially to the research field “water-sensitive urban development”; and (b) organizes sustainable practice-oriented capacity development.	SEA-Germany	WP 7, 8, 9 <ul style="list-style-type: none">• Online learning and knowledge exchange platform.• Scientific contributions to International PUW Conferences.• Scientific publications and final PUW publication (open access).• Integration into existing SEA and SEA-Germany master programs, support program for practitioners, young professionals, early researchers and alumni activities.• Blended training courses for practitioners in SEA.• Strategic plans of UGM and AIT for the establishment of regional knowledge hubs.	<ul style="list-style-type: none">• Minimum 3 PhD and 20 Master Theses are completed that are directly related to the project implementation.• 10 internships completed• 200 representatives (from civil society, water management, urban planning, sector associations, etc.) have participated in Blended Training Courses• Minimum 8 scientific paper publications based on contextual research findings• 2 publications of PUW periodical
	6. Positive stimuli for the intensification of economic/academic relations between Germany and the SEA region in the field of water resources management and urban development are generated.	Germany-SEA	WP 8, 9 <ul style="list-style-type: none">• Specific experiences from German public entities/water utilities are reflected in the vision building/scenario development of partner cities (Living Labs)• Specific experiences from German public entities/water utilities have contributed to the strategic design process and the establishment of structures of co-production in the Living Labs.• Specific experiences from German public entities/water utilities have contributed to transformation processes for public and private entities to elaborate effective business models.• Innovative business/utilities partnerships between SEA and Germany established.	<ul style="list-style-type: none">• 8 key recommendations from German public entities/water utilities integrated in planning documents of Vision Building/Water-sensitive Modelling and strategic configuration of pilot projects (Source: Planning documents).• 6 specific working relations between German and SEA based entities/utilities/sector associations established (Source: Minutes of exchange processes).

5. Interdisciplinary and Transdisciplinary International Cooperation and Work Distribution

5.1 International Cooperation Partners, Project Management and Contributions

The research process of Polyurbwater is organized in 9 WPs that interlink the micro, meso and macro levels (Fig. 7). The contribution of each project partner is displayed in the table below and the attached Letters of Intent (LOIs).

The management of the research process aims to ensure that the partners are able to effectively contribute their specific research capacities in accordance with the project planning. Here, **interface management and expectation management** is necessary to ensure that the interests and action rationales of the cities and those of the research community are closely linked in a continuous process. The fine-tuning of processes between consortium

partners, partners and local structures - as already practiced during the Definition Phase - will take place on an almost daily basis, particularly through the use of virtual media.

5.2 Contributions of the International Partners

Partner Cities (Kratie, Sam Neua, Sleman)	The partner cities will provide free of charge technical staff and infrastructure for the realization of the Living Labs. The monetary value per city is estimated at approx. 250,000 (i.e. total value of 750,000 €) during the R&D Phase. WP 2, 8, 9
AKSANSI, Indonesia	AKSANSI is a communication forum and umbrella of community-based organizations in the sanitation sector throughout Indonesia. AKSANSI will support the research in Sleman on effective schemes of co-production with a focus on community development. AKSANSI provides free of charge its extensive database, built up over 10 years, for the monitoring of community-based sanitation processes (3000 entries for individual plants). WP 2, 5, 7
Asian Institute of Technology, Thailand	AIT promotes technological change and sustainable development in the Asian-Pacific region through higher education, research and outreach. AIT will conduct research mainly on integrated water-sensitive infrastructure and the development of schemes for its effective governance. It will support the development of capacity development formats mainly intended for professionals. AIT will contribute to the project free of charge tools from its knowledge hub "Regenerative Sanitation and Knowledge Hub". WP 2, 3, 4, 7, 8, 9
Bremen Ministry for Climate Protection, Environment, Mobility, Urban and Housing Development, Germany	The state ministry simultaneously carries out municipal tasks of the city of Bremen and contributes to the project with its experiences in the formulation of strategies for climate change adaptation. The ministry makes available free of charge its experience of academic-economic cooperation and selected instruments relating to climate change adaptation. Dr. Vosseler is contracted (Dienstfreistellung) for selective advisory services. WP 2, 3, 5, 7, 9
Cambodian Institute for Urban Studies	As a non-profit organization, CIUS contributes to enhancing the understanding of capacities and competencies in contemporary and evolving urban planning and management approaches, innovating and applying these in the Cambodian and regional contexts. CIUS will support research at interface between water-sensitive urban design and water management in Kratie. CIUS will provide the project with free tools generated in the framework of advisory processes. WP 2, 5, 6, 7, 8, 9
City Alliance, Southeast Asia	The "City Alliance: People, Sanitation, Cities" is an international network of public, civil society and scientific institutions that promote the decentralized management of urban water. CA will facilitate knowledge sharing among partner cities. It provides the project with free access to the experience and expertise of its SEA-wide network (beyond the immediate partner cities) in developing decentralized water infrastructures. WP 2, 6, 8, 9
Environmental Sanitation Cambodia	ESC is an independent Cambodian non-profit, non-partisan, non-governmental organization. ESC will support research on the technical configuration of water-sensitive infrastructure in Kratie. ESC contributes to the project free of charge knowledge for the development of decentralized water infrastructures in Cambodia, which was generated within the framework of other international cooperation projects. WP 2, 3, 4, 7, 8, 9
German Water Partnership e.V.	GWP is the only network in the internationally oriented German water industry, which unites around 350 companies. GWP will make available to the Polyurbwater network experiences on practice proven solutions of urban water management. WP 8, 9

Hamburg Wasser, Germany	Hamburg Wasser (Hamburg Water) is Hamburg's drinking water supply and wastewater management company. It will support the project mainly by supporting the research process on hybrid infrastructure and respective governance schemes. It will provide the project with its expertise in the field of municipal development free of charge over and above the invoiced expert days. WP 2, 3, 4, 5, 6, 7, 8, 9
Inc. Square Limited, Thailand	Inc. Square Limited, Bangkok, is a medium enterprise that act in the region as technology providers. It will share with network partners free of charge its knowledge about challenges for market development. WP 2, 5, 8, 9
Kota Kita Indonesia	Yayasan Kota Kita is a non-governmental organization based in Indonesia with expertise in urban planning and citizen participation in the design and development of cities. Kota Kita will contribute to action research to develop tools and methods, lead the implementation of community and local government co-design processes. By sharing experiences from Indonesia, Kota Kita will contribute to the formulation of sustainable urban development practices in Laos and Cambodia. Kota Kita will contribute free of charge bringing its network and sharing its knowledge and experience about existing local co-production forms, their challenges and prospects of success. WP 2, 5, 6, 7, 8
Public Works and Transport Research Institute, Laos	PWTRI is established by the Ministry of Public Works and Transport and embodies the technical assistance of the ministry in areas of project planning, research, capacity development, monitoring and evaluation. PWTRI will accompany the research process in Sam Neua from the government side and develop its capacities in the field of water-sensitive urban development. It provides its expertise as well as free premises/infrastructure for dialogue events. In addition, PWTRI will contribute free of charge tools and results generated by other measures in cities in Laos to the project. WP 2, 3, 4, 5, 6, 8, 9
United Nations Economic and Social Commission for Asia and the Pacific	UNESCAP has the mandate to strengthen the capacities of its member states' governing bodies for more effective and efficient policy formulation and implementation of sustainable and inclusive development. The Polyurbwater network will profit from use of the existing UNESCAP's knowledge management platforms such as the SDG Helpdesk and the partner will help facilitate upscaling of developed instruments within the SEA-region. WP 7, 8, 9
Universitas Gadjah Mada, Indonesia	UGM is an Indonesian public ivy league research university. The Department of Architecture and Planning as well as the Faculty of Geography will both conduct research on the Living Labs in Sleman and contribute to capacity development programs. By involving both of these teams, the project will benefit from unique insights and experiences at the nexus of water management and urban planning. The departments will provide the project with free training infrastructure. To this end, UGM Department of Architecture and Planning will contribute free of charge tools and approaches to sustainable urban planning developed in its global academic network while the Faculty of Geography will contribute free of charge its vast knowledge on hydrology and urban water resources in the Indonesian context. WP 2, 3, 4, 5, 6, 7, 8, 9
Vietnam Academy for Water Resources Vietnam	VAWR is one of the leading water resources management and technology institutions in Vietnam. In collaboration with academic partners in SEA and Germany, VAWR will develop an academic program on polycentric water management in the region. VAWR will provide free of charge, in addition to the provision of learning infrastructures, the expertise of its research network in the topics of disaster risk reduction and climate change adaptation, as well as providing advice to governments at national level and to cities. WP 3, 4, 7, 8, 9

5.3 Cooperation and Project Management Risk Mitigation and Preventive Strategies for Conflict Management

By investing strongly in needs and priority assessments of partners and designing projects that directly respond to these needs, the demand-oriented Polyurbwater project substantially mitigates risks. With the LOIs, the partner cities have provided the "licence-to-operate" for the research process. The effects of political and budgetary changes in the partner municipalities may require adaptation in city cooperation processes. The multi-layered cooperation management approach and the regional structures of BORDA will ensure continuous information flow between partners and early adaptation to changing framework conditions. Therefore, emerging and potential risks in the overall networks may be detected at an early stage, allowing appropriate mitigation measures to be initiated in response. Risks beyond the system boundaries of the project (e.g., further restrictions due to COVID-19) are cushioned by the flexible methodological and management approach of the project (e.g., increased use of virtual media and other innovative communication formats). The Data Management System follows international standards of data management and data security. Particularly in the context of the conceptualization of Living Labs, scientists and experts will collect quantitative and qualitative data on site. These data will be processed or communicated in a way that respects individuals' privacy and national/international data security standards. All participants of the project team must follow these standards in order not to risk the license to operate of the project.

6. Relevance to Funding Objectives of the BMBF Support Program

Polyurbwater fully complies with funding objectives of the support program; it contributes to the achievement of the internationalization strategy of the Federal Government, Paris Declaration the "New Urban Agenda" (Paragraphs 2, 14a, 51, 70, 85, 91, 95, 98, 99, 109) and the "Sustainable Development Goals of the United Nations" in the strategic field of urban development (SDGs 11, 6, 9, 13, 16, 3, 1, 17). Following the objectives of the BMBF support program, existing planning procedures and approaches of the cities are important reference variables for the approaches to be developed. The integrated approaches to urban planning are aimed at overcoming sector-specific silo thinking, avoiding isolated solutions, developing instruments of efficient urban management and promoting resilient infrastructure systems, especially in urban transition zones. Resilience and the associated risk management in the event of extreme weather events and natural disasters in rapidly growing cities is to be strengthened by developing polycentric, participatory governance approaches and related capacity development. In its conceptual and methodological design, Polyurbwater follows priority fields of innovation for the future city (BMBF, 2015), including: a) civil society actors as drivers of urban transformation; b) strengthening and supporting municipal transformation; c) sustainable conversion of urban settlement and spatial structures; d) pioneer projects for urban infrastructure; e) tools and methods for planning and knowledge management; f) new framework conditions for urban innovation; and g) strategic financial management and business models. In addition, the project's communication concept includes considerations of the policy paper of BMBF on science communication (BMBF, 2019).

7. Expected Results and Utilization (Scientific & Economic)

Expected Research and Development Results	The project fills a significant gap in resilience research for secondary and tertiary and medium-sized cities in SEA. The results (e.g., outcomes and products) that will be generated by the project are presented in detail in Chapter 4.
Scientific Prospects of Success	The strong scientific prospects of success are mainly because the project corresponds to the growing interest of Southeast Asian research institutes in supporting the development of water-sensitive cities or the development of polycentric approaches. The technical and methodological design of the project will serve as a reference project for practice-oriented research networks in the field of "sustainable urban development in Southeast Asia", which aim to bring together academic institutions, municipalities, local and national government authorities, civil society institutions and the private sector. The academic partners have expressed their need for capacity development for an effective methodological design of Living Labs for academic-economic cooperation at the local level. The continuity of the project results and their contribution to the development of an emerging field of research will be ensured by an advanced science communication approach. Early career researchers in SEA will play a critical role to enhance the capacity of local academic institutions in the field of solution-oriented research at the intersection between water and urbanization, as well as in the field of practice-oriented education and training.
Economic Prospects of Success	Following intensive consultation processes, the participating cities confirmed the relevance of the project approach. In their willingness to make further resources available for the project, they expressed their view that the project has great prospects of economic success, not only for their own processes, but also for emerging economic opportunities (consulting services, tourism, etc.). This demand from cities and partners demonstrates that the project and the instruments that will be developed have a good prognosis with regard to sustainability and effective use of project funds. Secondary and tertiary cities in SEA are likely to offer considerable business potential for infrastructure development. The project's comprehensive capacity approach has the potential to contribute to the development of cooperation opportunities with German business stakeholders.
Scientific and Economic Applicability	The high degree of practical orientation and demand orientation towards the needs and interests of the cities and academic partners ensures the economic and academic applicability of the project results. The tools are developed from the realities of cities and therefore have a high application relevance. The contribution of the practical know-how of the specialist partners from Germany and their experience with projects of academic-economic cooperation will also contribute significantly to this applicability. The generated knowledge and tools will be made available as open source to interested professionals and the broader public both in the region and worldwide, thus facilitating wide range applicability.