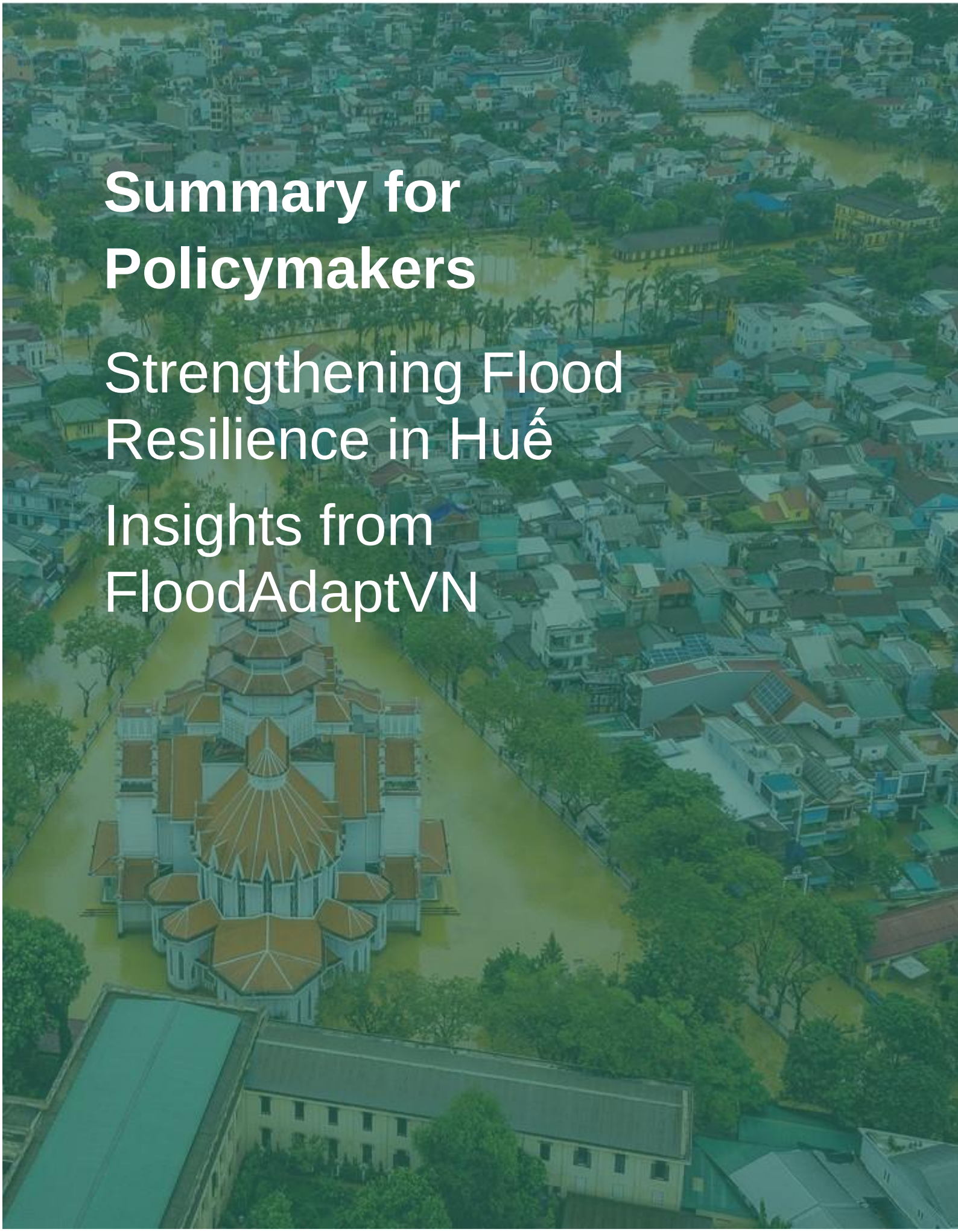

# Summary for Policymakers

## Strengthening Flood Resilience in Huế

## Insights from FloodAdaptVN

# Strengthening Flood Resilience in Huế – Insights from FloodAdaptVN

# A Summary for Policymakers

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## The Need for Enhanced Flood Risk Management

Flooding is one of the most pressing challenges in centrally governed Huế City and its surrounding administrative areas (hereafter referred to as Huế), driven by climate change, rapid urbanization, and environmental degradation. Extreme flood events, such as the devastating floods of 1999, 2020 and 2022, as well as frequently occurring, less extreme events, have highlighted the region's high exposure and vulnerability, underscoring the urgent **need for improved flood risk management and adaptation**. Traditional flood risk reduction approaches, primarily focused on structural measures such as dams or reservoirs, are increasingly insufficient to address the rising frequency and severity of floods considering the dynamics of climate and socio-economic change. A shift toward risk-informed planning**, integrating risk knowledge, a broad spectrum of solutions** (incl. ecosystem-based solutions), advanced analysis tools and information systems, **is essential.**

**Against this background, the German Federal Ministry Research, technology and Space (BMFTR) has funded the FloodAdaptVN project**, an interdisciplinary and applied research initiative led by the German Aerospace Center (DLR), in close collaboration with Vietnamese and German partners and stakeholders. The project integrates Earth observation, hydrological and hydraulic modelling, comprehensive risk assessments (incl. future climate and socio-economic scenarios), and ecosystem-based adaptation (EbA) to develop innovative tools for flood risk management. A central component is the **Flood Risk Adaptation Measures and Evaluation (FRAME) portal**, a WebGIS-based decision support system aimed at facilitating **evidence-based and risk-informed planning**.

FloodAdaptVN has co-created **scientifically grounded and policy-relevant insights** to support **decision-makers, local authorities, and communities** in building more **flood resilient futures**. This policy brief presents the project's key findings, highlights prioritized adaptation strategies, and outlines policy action required to **enable sustainable flood risk management in Central Vietnam**.

***"Rising flood frequency and severity demand smarter, integrated risk management."***

Figure 1. Flood in Huế in October 2020 (Source: Nguyen Hoang Khanh Linh).

## Understanding Current and Future Flood Risks and Impacts

To enhance the region's resilience to floods and thereby reduce future flood impacts, it is crucial to understand flood risk and its underlying drivers. The global scientific community defines risk as a function of three key components: flood hazard, exposure and vulnerability. To this end, it is important to:

- Identify potential flood levels, including inundation depths and the spatial extent of flooding (**flood hazard**);
- Understand who and what, including people, economic activities, infrastructure, and ecosystems, are located in flood-prone areas and therefore potentially affected (**exposure**);
- Determine how likely individuals and assets are to suffer adverse impacts when exposed to flooding (**vulnerability**).

All three components of risk are influenced by underlying social, economic, political and environmental processes, structures, values and norms (i.e., root causes). Recent floods have highlighted that flood impacts as well as their underlying drivers are closely interconnected. For example, health impacts and transportation disruptions have triggered cascading effects on livelihoods, while water contamination has contributed to additional health impacts. These and other interactions have been systematically assessed by the FloodAdaptVN project (see Figure 2).

### Key Results:

**Large parts of Huế are already prone to high flood hazard levels, with increased inundation depths and flood extents in the future**

Almost half (46%) of Huế's total area is currently exposed to exceptional floods, such as the 2020 event. While upstream areas are less affected, almost 90% of newly urbanized and downstream regions are prone to flooding, with inundation depths exceeding 2 meters in some locations. Future flood hazards are expected to intensify. Previously unaffected locations will be affected, while inundation depths in already affected locations will increase. Figure 3 illustrates the flood hazard extent and inundation depths for moderate climate and socio-economic development scenarios, which are considered realistic by local experts.

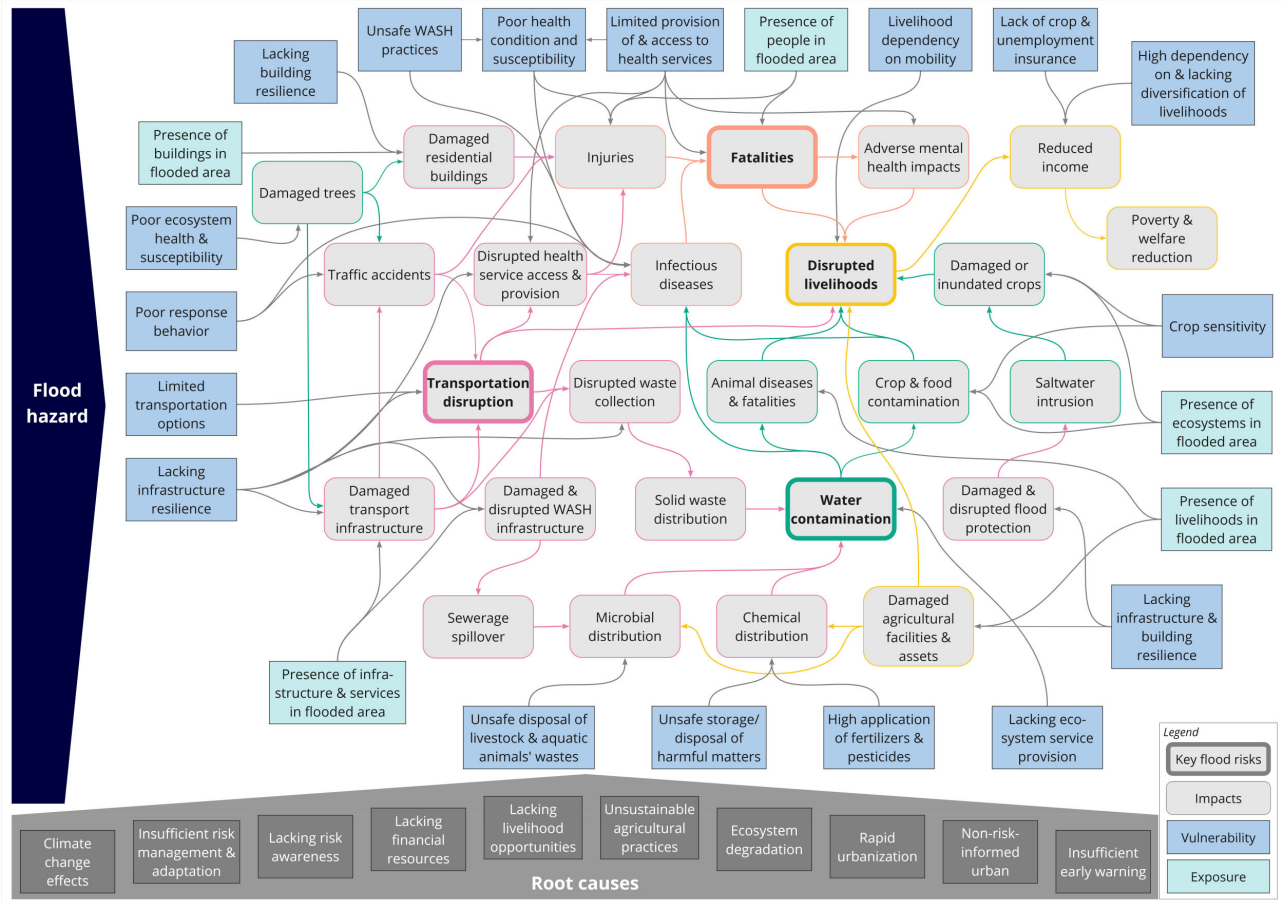


Figure 2: Interconnection of key flood risk drivers, root causes, and impacts in Huế (Source: UNU).

**Flood exposure is widespread and projected to increase due to future urban growth**

A large share of Huế's population, economic activities, infrastructure, and environment is already exposed to floods. More than three-quarters (76%) of Huế's population currently lives in areas prone to floods. In addition, 94% of health facilities in the Citadel, 99% of rice paddies, and 72% of roads in the downstream region are located within flood-prone zones. Scenario analyses conducted in the project suggests that the number of people and assets exposed to floods will rise, as Huế continues to expand, mainly into low-lying areas, resulting in increased potential impacts in the future.

**Vulnerabilities contribute to severe impacts and will worsen without targeted action**

Vulnerability patterns differ across Huế, due to the city's diverse urban regions. For example, the upstream region is characterized by the highest vulnerability to transportation disruptions, while the downstream region is particularly susceptible to water contamination.

Key vulnerability drivers include inadequate response behavior, substandard building conditions, lack of insurance coverage, and degraded ecosystem health. If current trends continue, vulnerabilities will increase for the majority of residents in Huế, leading to a rise in expected impacts across the city.

**Underlying root causes drive flood risks and must be tackled to prevent future escalation**

Flood risks are driven by a range of underlying root causes. For instance, the conversion of natural ecosystems into highly sealed, densely populated urban areas, as notably observed in Huế's new development zones, amplifies hazards, increases exposure and heightens vulnerabilities, resulting in significant negative impacts on public health, livelihoods, transportation, and water quality. Additionally, human-induced climate change, inadequate risk management, and limitations in risk-informed planning further exacerbate flood risks. To effectively reduce future risks, these root causes must be systematically addressed.

***"Risk-informed planning transforms uncertainty into smart, future-ready action."***

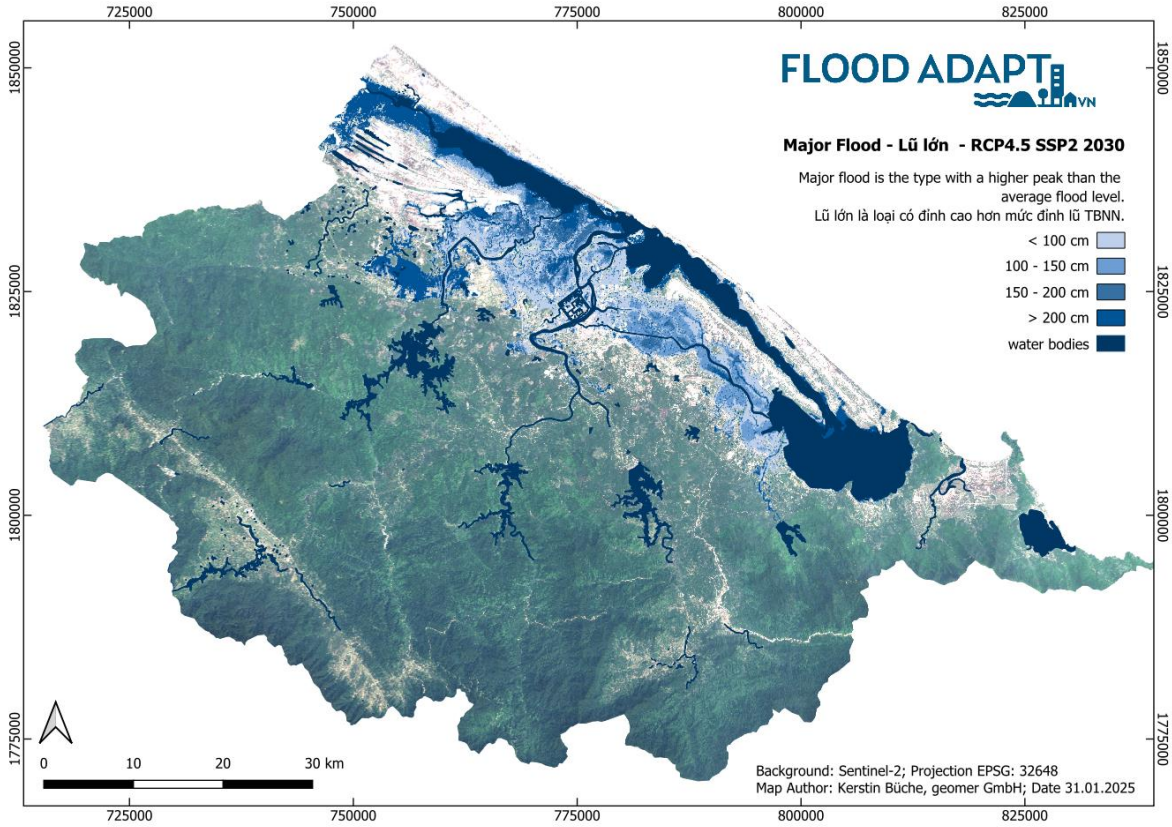


Figure 3: Major flood hazard under RCP4.5 / SSP2 scenario in 2030.

**BOX 1: Quantitative Flood Risk Assessment Using the CLIMADA Tool**

In order to provide decision makers an additional source of information, a quantitative analysis of future expected impacts was conducted following the Economics of Climate Adaptation (ECA) framework and employing its open-source modelling tool CLIMADA. Inputs for this analysis included the spatial distribution of people and key assets, their susceptibility to damage, and the flood model developed within the project, which incorporates future scenarios based on different climate change pathways. Subsequently, several adaptation measures identified in the project were evaluated for their potential to reduce projected future impacts. Across all assessed asset categories, including road and building infrastructure and agriculture, the current annual average impact is estimated at 402 billion VND. This figure is projected to increase to 1,748 billion VND under a moderate climate change scenario (RCP4.5), and to 2,826 billion VND under an extreme scenario (RCP8.5) by 2050.

For the population, it is currently estimated that an average of 1,600 people are affected by floods annually. This number is expected to rise to over 3,800 people per year by 2050 under a moderate climate scenario, and to more than 7,000 people annually under an extreme climate scenario.

In terms of monetary damage to specific asset classes, current average annual flood-related damage to road infrastructure is estimated at over 75 billion VND. This figure is projected to increase to more than 325 billion VND under the moderate scenario, and to over 525 billion VND under the extreme climate scenario by 2050.

To assess the benefits of adaptation, a selection of nine adaptation measures was incorporated into the model. Under the moderate climate scenario, these measures could avoid total expected climate-related damage by approximately 21% (equivalent to 34,489 billion VND out of a total of 164,229 billion VND). Under the extreme climate scenario, the same set of measures would reduce expected damages by around 17% (equivalent to 40,037 billion VND out of 239,512 billion VND).

***"To manage future flood risk effectively, exposure and vulnerability must be addressed alongside hazard."***

## Opportunities for Flood Risk Management and Adaptation in Huế, Central Vietnam

This section shifts the focus from understanding current and future risks to identifying actionable solutions for flood risk management and adaptation in Huế.

A range of measures was identified to address the various components of flood risk as well as their underlying root causes. While flood risks and impacts are primarily concentrated in the urban and peri-urban areas of Huế, some of their drivers originate upstream. Therefore, effective solutions must adopt a catchment-wide approach, extending from the mountainous upstream regions (e.g., sustainable forest management to retain runoff during heavy rainfall events) to the coastal zones, where coastal forests serve as natural buffers against coastal flooding.

In addition to the spatial distribution and specific functions of these measures, different types of adaptation options were identified. These need to be combined strategically to enable a holistic flood risk management approach:

### 1. Structural and Physical Options

**Ecosystem-based measures** refer to the use of biodiversity and ecosystem services as part of an overall adaptation strategy to help people adapt to the adverse effects of climate change. An integrated catchment-based approach is particularly relevant for implementing ecosystem-based measures, as indicated above.

**Technological measures** refer to innovations and tools to enhance flood risk management and address climate impacts. The FloodAdaptVN project developed a specific tool targeting this type of option, called FRAME. In addition to the existing early warning system in Huế, we identified the shift from hazard-based forecasts (*"what the weather will be"*) to actionable impact-based early warnings (*"what the weather will do"*) as a key innovation.

**Engineered and built environment measures** refer to hard infrastructure or structural measures implemented to address flood risk and support adaptation. Examples include dam reservoirs or flood control gates, which are already in place. We recommend complementing these with structural housing adaptations in areas with high exposure to further enhance resilience.

## 2. Social Options

**Informational measures** focus on providing accessible knowledge, relevant data, and user-oriented tools to support evidence-based decision-making and build capacity for flood risk management and climate adaptation. While many awareness campaigns have already taken place, there is a need for a more inclusive, whole-of-society approach, ensuring participation across diverse stakeholder groups.

**Educational measures** aim to build long-term capacity by enhancing individual and community knowledge through targeted awareness-raising and skill-building initiatives. Particular attention should be paid to vulnerable groups, ensuring that communication and outreach are adapted to their specific needs and contexts.

**Behavioral measures** refer to efforts aimed at encouraging changes in individual and collective behavior to cope with flood risk and climate impacts. This includes promoting risk-aware decision-making and fostering a culture of preparedness at all levels of society.

## 3. Institutional Options

**Institutional options** encompass governance structures, policies, legal frameworks and strategic planning processes, as well as mechanisms for cross sectoral and multi-level cooperation (see next chapter).

Figure 4: Flood level in Huế (Source: Felix Bachofer).

## Key Recommendations

- **In-depth risk knowledge** (including insights into the drivers of flood risk and the identification of particularly vulnerable groups) is essential for developing fair, targeted, effective, and sustainable risk management and adaptation strategies.
- The selection of measures should **combine multiple approaches** (including structural, social and institutional options) to effectively address the key components of flood risks and their underlying root causes.
- A **catchment-based approach**, that accounts for upstream-downstream dynamics should serve as the foundation for adaptation planning. This enables the integration of diverse flood risk reduction options, particularly ecosystem-based solutions.
- **Ecosystem-based measures** such as sustainable forest management and agroforestry in riparian buffer zones, offer viable and nature-friendly means to reduce flood risks and enhance co-benefits.
- **Governance-oriented actions**, with risk-informed urban planning and multi-level, cross-sectoral coordination, can significantly strengthen institutional capacities for integrated flood risk management.
- The varied performance of individual measures in the project evaluations highlight the need for **bundled solutions**. Combining complementary measures can create synergies and improve overall flood resilience. This approach will be a core focus in the upcoming implementation phase, aimed at supporting the development of a comprehensive adaptation strategy for Huế.
- **Geospatial decision-support tools,** such as the FRAME platform developed under FloodAdaptVN, enable scenario-based flood risk assessments and spatial visualization of impacts and interventions, thereby enhancing risk-informed planning and decision-making.

***"Planning with scenarios turns today's decisions into tomorrow's resilience."***

## Policy Framework & Institutional Considerations

To address flood risk reduction, national and local level authorities have developed a comprehensive policy framework and created appropriate administrative structures.

This chapter summarizes findings from the analysis of the institutional and policy frameworks and formulates policy recommendations to improve flood risk reduction and adaptation in general – and, in particular, to promote risk-informed planning and the integration of ecosystem-based solutions. These policy recommendations are grouped into six fields of action and are aimed at both the national and the Huế City level.

### 1. Current Situation: Findings from the Institutional and Policy Analysis

**i. Planning and policy framework:** Integrating flood risk management and adaptation into the planning and policy framework faces several challenges: Socio-economic and spatial strategies and plans for Huế have traditionally emphasized economic growth over flood risk reduction. Planning processes are structured around long-term strategies, requiring careful coordination when adjustments are needed; aligning socio-economic, spatial and sectoral strategies and plans remains a complex task. While disaster risk management has a well-established tradition in Huế, the integration of risk-informed planning is still evolving. However, there is a growing recognition of the importance of flood risk management and adaptation in policy and planning frameworks at all levels. In addition to plans aimed at long-term resilience and flood risk management, recent strategies and plans on socio-economic and spatial development increasingly incorporate flood risk reduction measures. There are also plans and projects that foster ecosystem-based solutions in particular.

**ii. Administrative action, planning and decision-making:** Flood risk management and adaptation are cross-cutting issues that must be integrated in administrative action, planning and decision-making processes and need to be addressed by all relevant departments, across sectors at all levels. This integration is hampered by the inconsistent use of data and GIS systems, by the prevailing economic orientation of decision-making as well as by the nature of the planning process which does not foster the integration of all relevant departments, stakeholders and expertise at an early stage. Furthermore, the responsibilities relating to flood risk reduction and adaptation are not yet clearly assigned to the departments. On the other hand, the Commanding Committee for Natural Disaster Prevention and Control and Search and Rescue of Huế City has already enhanced interdepartmental coordination.

**iii. Interprovincial and regional cooperation:** Flood risk management and adaptation require joint action of neighboring provinces/cities in Central Vietnam; challenges for this cooperation include the disparity in resources, the absence of a regional planning and decision-making level as well as the non-institutionalized nature of the cooperation. However, a number of interprovincial cooperation activities already exist, including search and rescue activities, joint river basin planning and knowledge exchange.

**iv. Capacity development:** Our research revealed a shortage of trained personnel for risk-informed planning and flood risk management, particularly at local levels. However, national and provincial policies emphasize capacity development and staffing local institutions accordingly. Regional universities and local-level think tanks have strong research programs and can play a key role in capacity building.

**v. Public financing:** Another challenge for the implementation of flood risk reduction and adaptation measures are funding gaps. Planning instruments often contain a list of measures with cost estimations, but national and local-level governments fail to secure reliable financing over longer periods of time. Risk-informed planning and the consideration of ecosystem-based solutions - as is increasingly being pursued - have the potential to help to reduce costs while enhancing resilience.

**vi. Technologies and procedures:** Several policy documents related to flood risk reduction and adaptation reflect the insufficient environmental monitoring and forecasting infrastructure, which needs expansion and modernization. On the other hand, Huế is progressive in the development and utilization of new technologies (e. g. 3D-GIS, Hue-S system) which facilitate data management, early warning and, possibly in the future, joint planning. In addition, there are many international research initiatives working on suitable technical solutions for improved flood risk management in Huế. In addition to the local Hue-S system, the decision-support FRAME system offers a scalable and interoperable WebGIS solution for risk assessment and adaptation planning complementing existing services. Risk knowledge gained through the project could be integrated into existing hazard-based early warning systems to foster the shift towards impact-based early warning and enhanced early action.

## 2. Policy Recommendations: Bringing Forward Flood Risk Management and Adaptation

In the following, policy recommendations are formulated on the basis of the above-mentioned findings. The policy recommendations are aimed at both the national and provincial/city level.

### i. Planning and Policy Framework

- **Integration of flood risk management and adaptation as cross-cutting themes:** Flood risk management and adaptation should - as called for by various policy documents - be integrated into all strategies and plans. This applies in particular to socio-economic and spatial development plans. Moreover, land-use changes required for major projects should carefully consider future flood risks.
- **Alignment of strategies, plans and measures:** Overarching strategies and plans need to be aligned with sectoral, implementation-related flood risk reduction and adaptation measures to avoid conflicts of objectives and competing approaches among different departments.

### ii. Administrative Action, Planning and Decision-Making

- **Establishment of a common database and GIS system:** Joint planning requires a common database that provides all relevant data (including socio-economic data, spatial data, environmental data, data on flood risk and soil performance, etc.) and the use of a standardized (Web-)GIS system, which allows existing and draft plans to be viewed.
- **Rethinking of the planning process:** Socio-economic, sector and spatial planning – taking current and future flood risks into account – should be carried out in an inclusive manner, with early and continuous participation of all relevant departments and stakeholders, including social organizations, communities, vulnerable groups and the private sector.
- **Clear allocation of responsibilities:** To avoid gaps and overlaps in the fulfilment of administrative tasks related to flood risk management and adaptation, clear competencies and responsibilities should be assigned to the relevant departments.

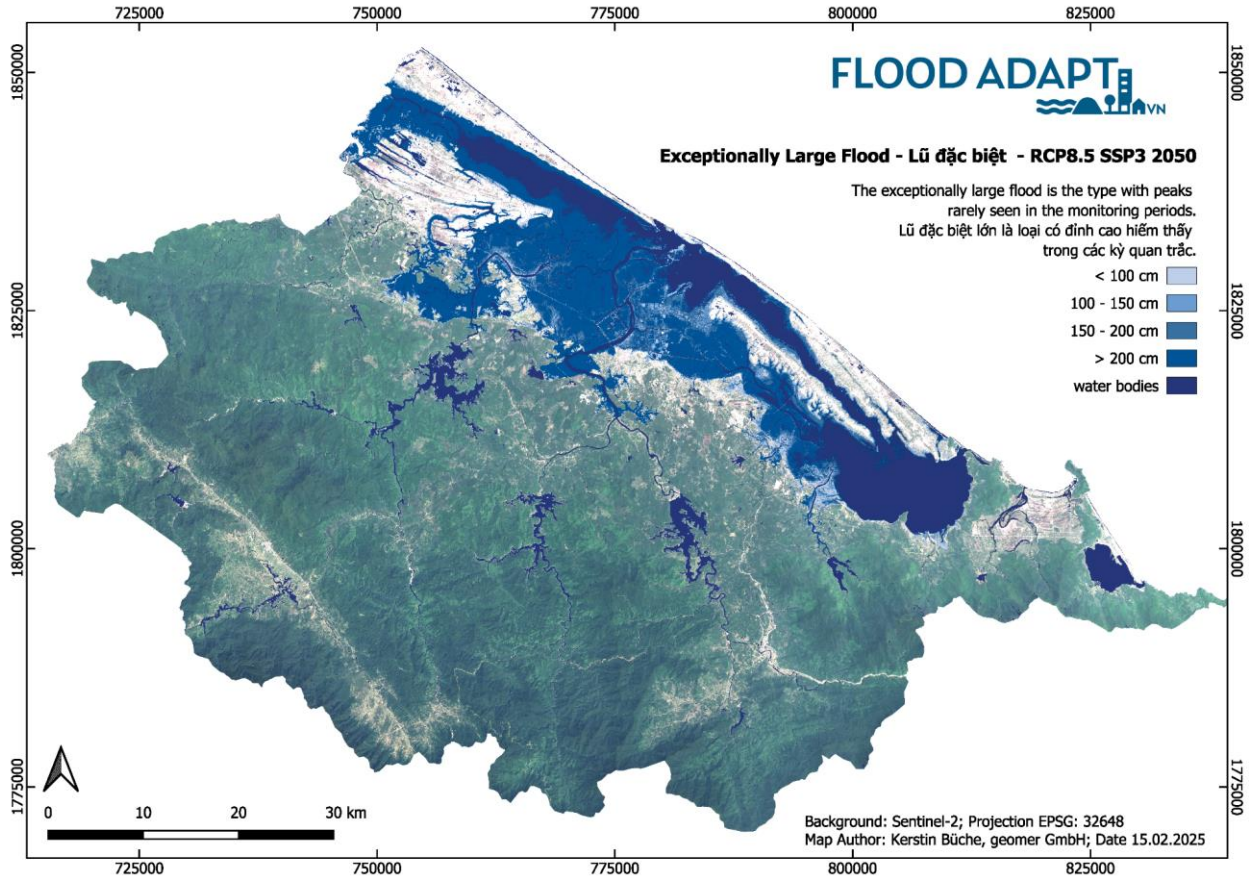


Figure 5: Exceptionally large flood hazard under RCP8.5 / SSP3 scenario in 2050.

- **Advance interdepartmental cooperation:** Cooperation between departments should be improved and intensified in order to facilitate joint, proactive planning, promote the exchange of information and minimize conflicts and overlaps between the departments' individual flood risk reduction and adaptation activities.

**iii. Interprovincial and Regional Cooperation**

- **Establishment of joint regional planning for flood risk reduction and adaptation: T**o support a joint approach by the provinces/cities in Central Vietnam and to harmonize flood risk management and adaptation strategies and measures, efforts must be made to establish a regional planning level, mainly organized by the concerned provinces/cities. Alternatively, the national government, which is currently responsible for regional planning, should develop a planning instrument for flood risk management that is co-developed with the active participation of the provinces/cities.
- **Expansion of interprovincial cooperation:** The provinces/cities should further develop opportunities for cooperation beyond information exchange and individual projects, for example by developing a regional approach to flood risk management and adaptation, coordinating spatial planning and establishing joint knowledge management systems.

**iv. Capacity Development**

- **Boosting capacity development:** In order to make the administration fit for flood risk management and adaptation, programs for capacity development, training and continuing education should be created and financed. National training standards for personnel working in flood risk management could also be developed.
- **Integration in university curricula:** Flood risk management and adaptation should also be incorporated into university curricula as cross-cutting themes.

**v. Public Financing**

- **Sustainable financing:** The financing of adaptation measures must be secured; investments should be integrated into public budget planning at all levels for multiple years.
- **Exploration of climate finance:** As a complement, opportunities for climate finance and risk transfer mechanisms need to be explored.
- **Consideration of alternatives:** Cost/benefit analysis of adaptation measures to identify alternatives or complementaries to already planned solutions should also be considered, e. g. risk-informed spatial planning and nature-based solutions.

**vi. Technologies and Procedures**

- **Strengthening of monitoring and forecasting:** The environmental monitoring and forecasting systems need to be expanded and modernized; information provided by these infrastructures should be integrated in the existing Hue-S system.
- **Application of innovations:** Technical innovations resulting from research initiatives should be integrated into work processes.
- **Reduction of parallel structures:** Parallel technical structures, e. g. GIS systems and data bases, should be dismantled to ensure transparency, to save resources and costs.

Figure 6: Sluice gate at the Tam Giang lagoon (Source: Felix Bachofer).

## Core Recommendations for Policy & Action

### Institutionalizing risk-informed planning

Mandate the integration of data on current and future flood risks into spatial planning and infrastructure development. Planning processes should consider both current and future flood hazard scenarios, exposure, and vulnerabilities, ensuring future developments and policy decisions are risk-informed.

In addition, strengthen coordination between disaster risk management, urban planning, flood affected economic sectors, and environmental agencies to create a more cohesive flood risk governance framework.

### Mix of measures needed to address diverse risks, as there is no silver bullet in tackling flood risks in Huế

A combination of structural options, technological options (e.g. impact-based early warning), social options (e.g. awareness & capacity building), and ecosystem-based options is essential to comprehensively reduce flood risks.

### Ecosystem-based adaptation offers strong leverage points for addressing interconnected flood risks

Several entry points for comprehensive disaster risk management were identified based on the outlined risks. First and foremost, ecosystem-based adaptation solutions are promising as they help address key root causes, such as ecosystem degradation, thereby sustainably reducing current and future risks.

### Measures should address all risk drivers, particularly underlying root causes, and not just focus on hazard reduction

While hazard reduction is important, it is equally important to tackle increasing exposure and vulnerabilities, and even more critical to address underlying root causes to avoid the progression of risks and impacts. Measures should be designed and evaluated based on their effectiveness in addressing hazard, exposure, vulnerabilities, and root causes.

### Expanding data access, digital tools & knowledge sharing

Ensure access to flood risk information and climate projections through platforms like FRAME, enabling evidence-based decision-making across all levels of governance.

In addition, enhance capacity building programs by integrating flood risk management, remote sensing applications, and adaptation planning into university curricula and vocational training programs.

Finallyy, encourage cross-sectoral and international knowledge exchange to leverage best practices in flood adaptation, risk modeling, and digital decision-support tools.

Figure 7: Mountain riparian forest (Source: Felix Bachofer).

## Conclusions & Call to Action

Flood risks in Central Vietnam are escalating due to climate change, rapid urbanization, and environmental degradation. The FloodAdaptVN project has provided crucial insights into flood risks, their interconnections, underlying drivers and root causes as well as possible adaptation strategies. Translating this knowledge into concrete policy actions will be imperative for improving risk-informed planning and implementation in the long term.

To enhance **resilience**, decision-makers should **mainstream risk-informed planning**, scale-up **ecosystem-based adaptation solutions**, and strengthen cross-sectoral **multi-stakeholder collaboration**. The findings of this project offer a **science-based foundation** for improving flood risk management and adaptation, ensuring a safer future for communities in Huế and beyond.

### Next Steps

- **Policy Adoption**: Integrate FloodAdaptVN results into **national-level strategies** for natural disaster prevention, response and mitigation as well as into **local-level strategies and development plans**.
- **Implementation & Scaling**: Leverage digital tools like FRAME to inform decision-making at the **city, provincial, regional and national levels**.
- **Stakeholder Engagement**: Strengthen collaboration between government agencies, NGOs, researchers, communities, social organizations, and the private sector (e.g. by hosting workshops).
- **Financing & Sustainability**: Explore opportunities for **climate finance**, public-private partnerships, and risk transfer mechanisms beyond those currently in place, to expand adaptation efforts and reduce both for current and future flood risks and impacts.

### A Model for Other Flood-Prone Regions

Huế's approach to **comprehensive flood risk management** can serve as an **example for other vulnerable regions** facing similar climate challenges and further strengthen Huế as a role model for disaster risk management and governance. By integrating science, policy, and local knowledge, we can build a resilient future for communities at risk.

**Now is the time to act.** Implementing these recommendations will not only reduce flood risks but also contribute to advancing sustainable development and climate resilience in Vietnam.

Figure 8: View of Huế (Source: Felix Bachofer).

Figure 9: 2020 floods in Huế (Source: Ơi Huế & Nguyen Hoang Khanh Linh).

**Imprint**

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