Conceptual Framework for Scenarios Development in the project:
Water Futures and Solutions

Introduction

The major purpose of the Water Futures & Solutions initiative is to develop a set of adaptable, resilient and robust solutions and a framework to facilitate access to and guidance through them by decision makers facing a variety of water-related challenges to sustainable development, and a set of optional pathways to achieve plausible sustainable development goals by 2050. This document describes a conceptual framework that will be used:

- to support development of scenarios
- to guide integration with quantitative models
- to support development and assessment of solutions
- to support collaboration between project and stakeholder groups
- to present results to target audiences

Description of the Conceptual Framework

The framework visualizes (see Figure 1) freshwater systems as one face of a cube that is strongly interweaved with other face representing human activities (Economy, Society) and Nature as a whole. Dynamics of freshwater systems is also critical to human well-being. The Water Futures & Solutions initiative will go beyond producing scenarios but will also provide solutions (another face) for the growing water crisis. Again, the solutions developed, will be embedded in social and economic activities but for conceptual clarity they are represented by a separate face.

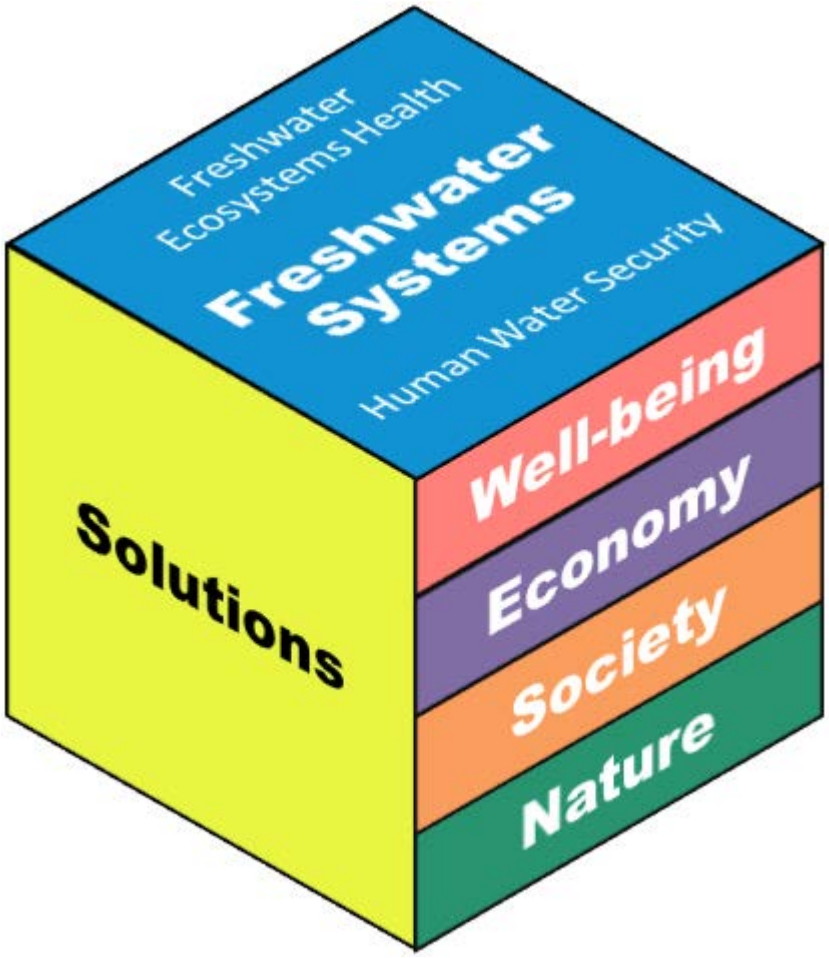

Figure 1. Multidimensional character of the scenario framework. In order to provide appropriate focus, Freshwater Systems and Solutions are visualized as separate faces of the cube. All elements that will be added to them will also be contained by one of the areas of the third face: Nature, Society, Economy or Human Well-being.

For the purposes of developing water scenarios, the driving forces and important outcomes considered to be the most dominant in determining the sustainability of the world water system within the time horizon of the exercise were grouped into a set of clusters each of them assigned to one of the components of Figure 1.

The multidimensional water system presented in Figure 1 is represented in a 2-dimensional space of Figure 2 with main drivers (Nature, Economy, and Society) at the bottom, freshwater systems dynamics and resulting outcomes in the middle and human well-being at the top. The diagram represents a systemic arrangement of drivers in the areas of *Nature*, *Society* and *Economy,* their relations to *Freshwater Systems Dynamics*, resulting threats to *Human Water Security* and *Freshwater Ecosystems* and its contributions to *Human Well-being*. Human well-being (top box in Figure 2), human water security, and freshwater ecosystem health are three central criteria to assess the desirability of the scenarios and benefits of proposed solutions. The diagram shows that human water security and freshwater ecosystems health are threatened by a series of stressors such as water shortage, flood risk, pollution, and river and catchment disturbance resulting from alteration of freshwater systems by human activities. Freshwater resource dynamics and water use is driven by a range of diverse factors grouped together in the areas of Nature, Economy and Society (only the major factors relevant for water scenarios are shown here). Each of the drivers in Figure 2 represents the entire cluster of factors that together with causal links between them can be further explored in order to link them with water and solutions variables. These clusters correspond to the groups of factors used in the IPPC-SSP narratives, too. A more detailed representation of freshwater resource dynamics and use as well as its links with driving forces are presented in the sub-diagrams (Figures 4 to 11).

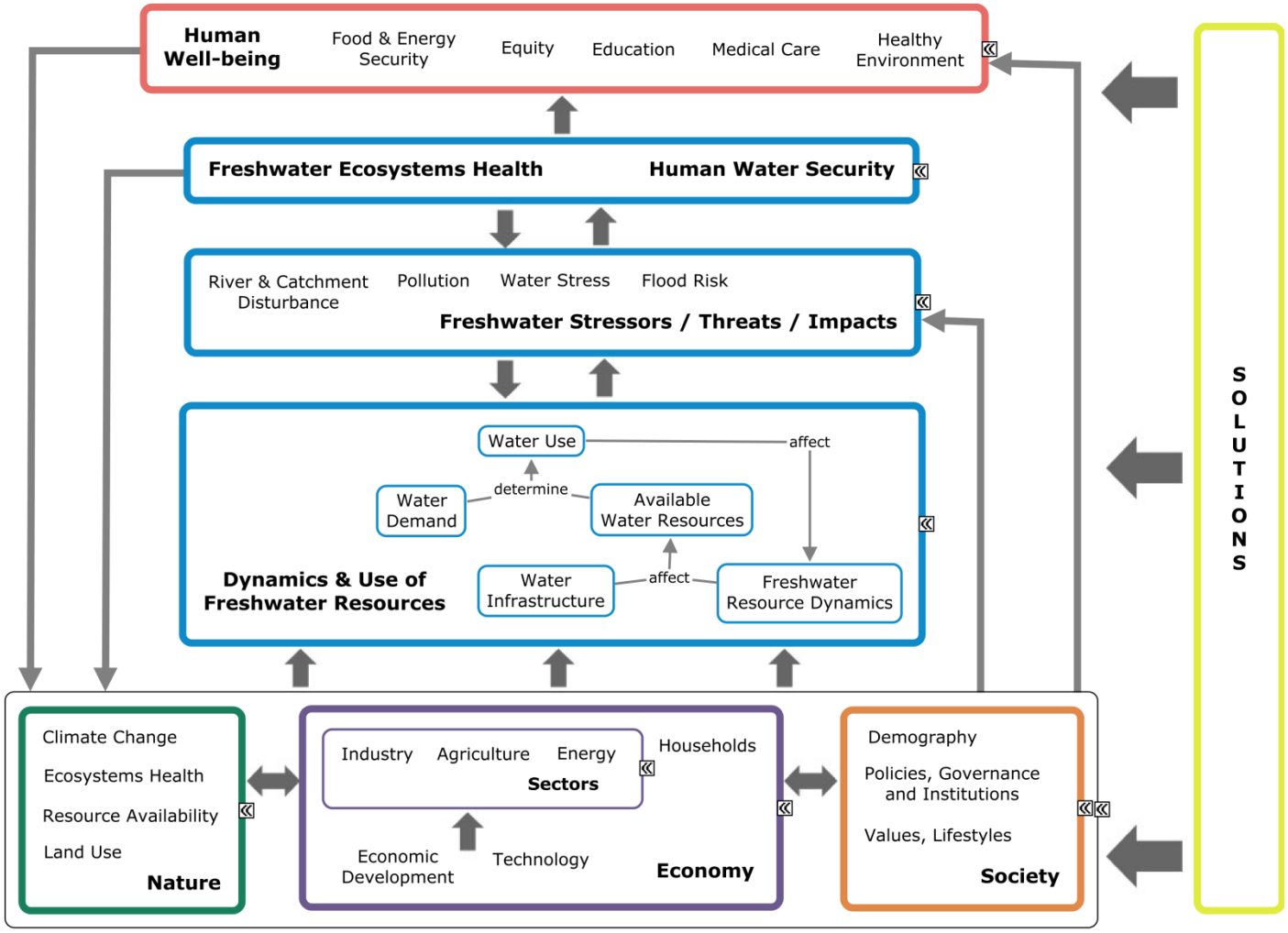

Figure 2. Key drivers and causal links affecting human water security, freshwater ecosystems and human well-being. See the text for further explanation.

Solutions that will be developed in the project are placed on the right. One needs to remember that this two-dimensional view distorts to some extent the actual system – the specific faces of the cube (as shown in Figure 1) are actually 'penetrating' one another. For example 'Policies and Institutions' represented in the Society component, when analyzed from Water perspective, at the same time belongs to Freshwater Systems. Human Water Security is placed in one of the Freshwater Systems boxes although it is, at the same time a part of the Human Well-being.

Similarly, Freshwater Ecosystem Health belongs also to Nature. Further, 'Solutions' that are depicted as a separate box will be placed in the specific areas of Society, Economy, Nature, and Freshwater Systems, respectively. Arrows indicate causal relationships between factors. Note that although the diagram is arranged to show the progression from drivers at the bottom, to outcomes at the top, there are many reciprocal links (feedbacks) that contribute to the complex dynamics of the whole system. All factors discussed here are to some extent interlinked; thus, Figure 2 is clearly a prioritized simplification made for the purpose of clarity.

Critical Dimensions

Critical dimensions are selected dimensions, representing system performance that will be used for evaluation of scenarios and solutions (see Figure 3). Dimensions in the Human Well-being, Freshwater Ecosystem Health and Human Water Security boxes will be used to evaluate the desirability and sustainability of the scenarios. Dimensions contained in the Nature, Economy and Society boxes represent important and uncertain factors, and will be used to explore a range of possible futures. Such exploration is necessary to develop robust solutions that work in these futures. The critical dimensions, as represented on figure 3 do not portrait all interactions between different factors (that is the purpose of the framework diagram in Figure 2). Instead they span the spaces for exploration of uncertainties and evaluation.

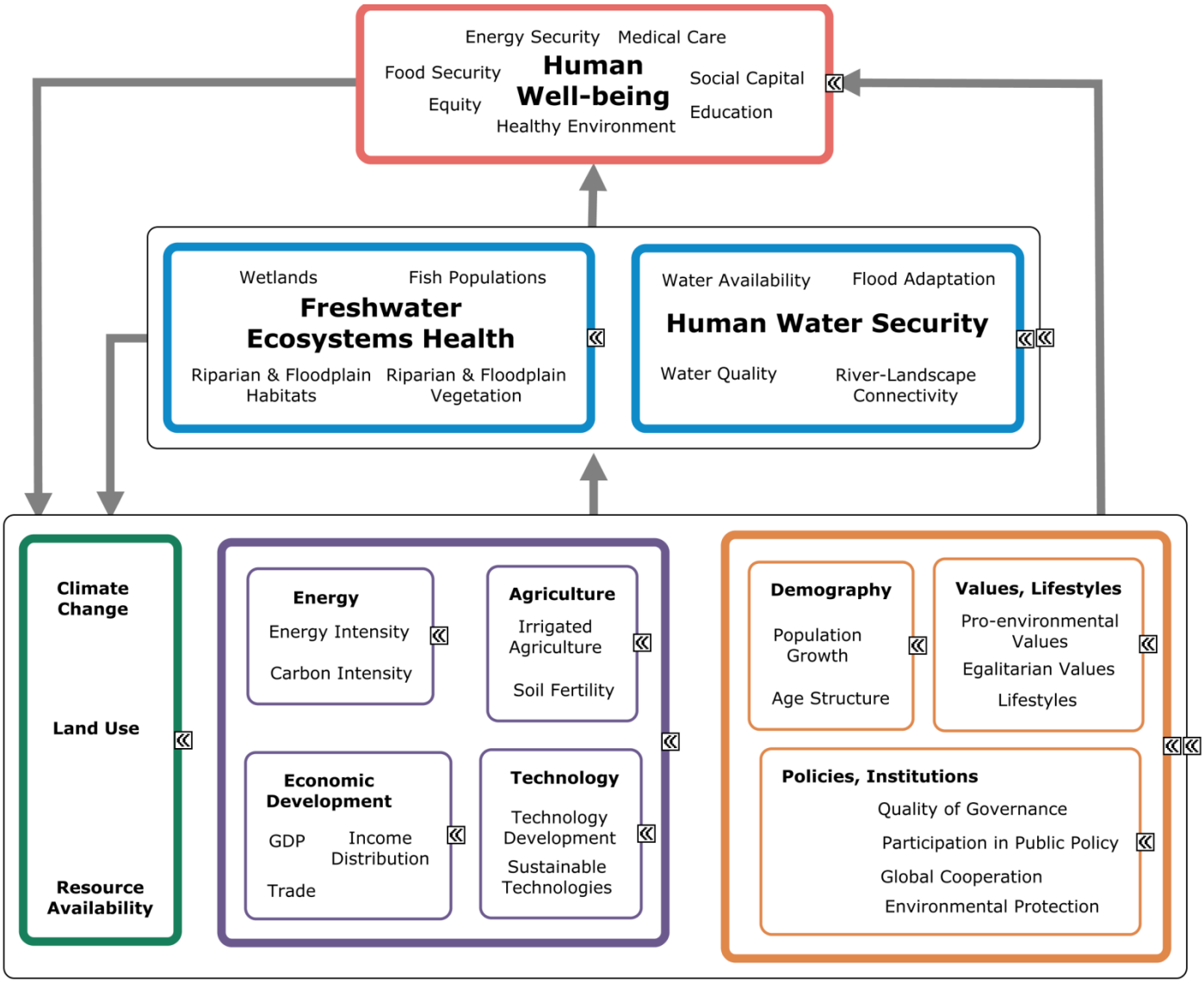

Figure 3. Critical Dimensions for the evaluation of scenarios results.

The expanded view of the framework

All the boxes of Figure 2 can be further expanded. Figure 4 presents expanded view of Freshwater Resources. *Freshwater resource dynamics* is a key factor determining w*ater supply capacity* that can be further increased by developing and maintaining w*ater infrastructure* such as dams, reservoirs, canals and irrigation systems. *Water supply capacity* can be decreased for the reason of inadequate water quality caused by *pollution*. The actual water supply (w*ater use*) is determined jointly by w*ater supply capacity* and w*ater demand*. *Water demand* is driven by developments in s*ociety* and *economy* but can be reduced by *water use efficiency* efforts. While it is commonly accepted that *water use* (w*ithdrawals* and *consumption)* is driven by the human activities, it also works in the opposite direction, where *water shortage* becomes a constraint on such human activities as *economic development*, production and *human wellbeing*. High rates of water use disturb freshwater dynamics, increase river pollution and lead to water shortage for people and ecosystems downstream. Traditional response to *Water shortage* in developed countries focuses on *water infrastructure* development that improves human water security but leads to river and catchment disturbance. *River and catchment disturbances* driven by economic activities affect *flood risk* in multiple ways. On the one hand flood protection infrastructure (dikes and reservoirs – a part of water infrastructure) reduces flood risk for target population. But disruptions in freshwater dynamics caused by all types of water infrastructure do not neutralize flood risk completely but rather shifts it in time and space. Moreover false sense of security from engineered flood protection drives floodplain development eventually leading to higher flood damages and very high costs of water infrastructure maintenance.

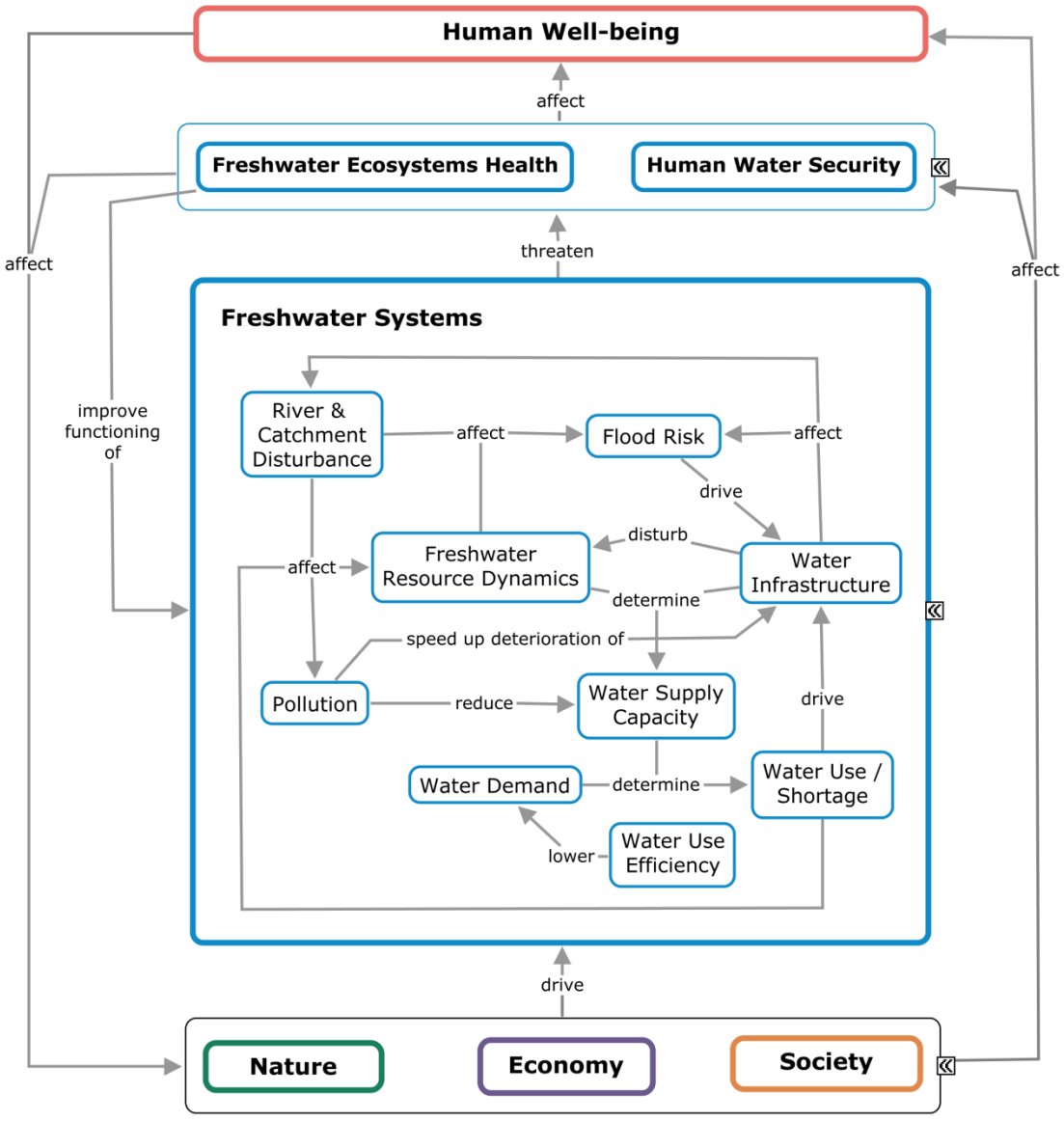

Figure 4. The Conceptual Framework – expanded view of Freshwater Resources

Transformation of freshwater systems threatens human water security that can be kept only in rich countries with the high cost of maintaining water infrastructure. At the same time river biodiversity is threatened almost

everywhere around the world. Human activities lead to fragmentation and degradation of riparian and floodplain habitats affecting negatively vegetation as well as fish and other animals populations.

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