

# **Ecosystem-based adaptation at scale through Building with Nature**

## **Towards Resilient Coasts in Indonesia**

### **River water availability of Demak Catchments**

#### *Executive summary*

Coastlines of Northern Java are facing a rapidly growing population and extensive industrial and agricultural developments. Their geological composition, existing of hundreds of meters thick alluvial clay deposits, and their low elevation make them extremely vulnerable to anthropogenic and environmental pressures. Subsidence and sea level rise are resulting in recurring flood events and massive coastal erosion. This is severely hampering economic development due to blocked transportation routes, loss of land for agriculture and aquaculture and costs for continuous repairs of public and private infrastructure.

To reduce erosion and limit flooding, construction of hard infrastructure is the most widely accepted approach. However, this will not be a feasible protection strategy for the whole of coastal Java as these measures are expensive, focus on single purpose solutions and require continuous and costly maintenance, especially, on soft muddy sub-soils. Therefore, the Building with Nature project is exploring innovative techniques that aim to halt erosion and restore sedimentation processes in the intertidal area through construction of permeable bamboo and brushwood dams. Newly built land with this approach will be conserved as a mangrove greenbelt that protects earthen seawalls and the hinterland, from wave impact, but also provide an indispensable nursery for fish, shellfish and shrimps.

Since sustainable use of fresh water resources is key to maintain a healthy mangrove forest and productive aquaculture ponds in the coastal zone we aim to increase our understanding of the fresh water system. In general, Building with Nature measures are strongly based on system understanding. Therefore, we evaluate the supply and demand of fresh water in the coastal communities in our project area. To do this, we use the SIWAMI model which makes use of a hydrological model in combination with meteorological, elevation, land use and soil type data. Agricultural irrigation intakes are also included in the model. In our project area there are three main rivers and their catchments that end up at the coast. From west to east these are: the Jragung, Buyaran and the Serang-Lusi. These rivers contain 80% of the total available fresh surface water. In the Serang-Lusi river in the East of Demak 50% of available water is concentrated. Fresh water availability in Western Demak, where most people and industry is concentrated, is limited. Upstream there are two main reservoirs, Rawa Pening and Kedung Ombo. Those reservoirs are not included in the SIWAMI model, which assumes natural flows. Under natural flow, discharges in the wet season are high but in the dry season shortages may be experienced.

In the model, demands are constituted by agriculture, mainly consisting of rice production, aquaculture, for fish and shrimp, and by domestic needs for coastal communities. Industrial needs and other upstream user groups are not evaluated in this study. For each user group the following conclusions were derived:

1. Crop farming: During the wet season supply exceeds demands largely. However, at certain years water availability in the dry period does not meet demand at main intakes for rice production. Especially at end and start of the cropping season this may pose problems.
2. Livestock: The production of broilers (poultry meat) in Demak requires at least five times more fresh water from wells than aquaculture, as the surface water is not of appropriate quality. Goat, buffalo and cattle are not produced in huge numbers.
3. Aquaculture: Overall there is enough available river water to support downstream aquaculture demands. However, water distribution to individual ponds may be a problem. More intensive industrial aquaculture systems that are scarcely distributed over the area use fresh water from deep wells to maintain salinity levels during the dry season. Coastal ponds report low productivity due to high salinity levels and with ongoing subsidence salinity intrusion will threaten aquaculture, livestock and agriculture productivity more inland as well.
4. Domestic: Coastal communities in the East of Demak receive fresh water from a water supply company and do not experience shortages. Communities in the West rely on ground water for their domestic needs. Demands of these communities cannot be met by the available river water within their own watershed. However, river water availability in the whole of Demak does suffice for domestic use solely. Once domestic use is combined with aquaculture use shortages may occur parts of the time.
5. Industry: although industry is likely responsible for most water use in Demak it was not included as a user group in the SIWAMI model. First, there is no data gathered of industrial uses of surface water and second, industry generally relies on ground water provided by their own wells.

There are several important aspects that have a large influence on water quantity and quality, that are not taken into account by this study. First, the current study does not specifically investigate water quality, but pollution of the Serang-Lusi river has been reported. Second, industrial uses have not been included but maps with registered ground water wells indicate that they may rely largely on ground water as their main water source. Lowering of the ground water level in Demak is measured at an alarming rate and from other areas across Indonesia and the world this lowering is linked directly to subsidence of the land. Local inhabitants of coastal villages report the occurrence of brackish water in their deep wells which points at depletion of the deep fresh ground water. Several scientific publications report subsidence rates of more than 8 cm/year in coastal areas of Semarang and in industrial areas of Demak.

Although the current modeling study shows that there is abundant yearly water supply in Demak through the three main rivers, the availability of water is unequally distributed over time and space. Water supply throughout the year is characterized by a wet and a dry season and the Eastern part of the province receives about 80 % of the river water. Therefore, water users are likely to experience regular shortages. Under natural flows that are assumed in the model these shortages become visible in both domestic and agricultural demands. Possible measures to manage shortages are:

1. Retain more water during wet periods, locally with storage tanks, retention basins or with extra reservoirs;
2. Optimize distribution of water throughout the year but also spatially by diverting water from one river to another;
3. Have a flexible cropping season;
4. Revert to other crops or aquaculture species;

5. Improve quality of available water and thereby increase potential for use.

Already, two upstream reservoirs are present in Demak. However, reservoir capacities were not taken into account in the present study and upstream rates of erosion are high causing reservoirs to fill in quickly with sediments and thereby loose capacity.

Considering increasing pressure on water resources from growing population and industrial development in Demak a more extensive study to optimize fresh water supply is required. During future study it is strongly advised to consider all user groups, including upstream, but also to link fresh water supply and demand in the Demak coastal area with Semarang city. Urban issues arising in Semarang, such as shortage of surface water, overexploitation of ground water and land subsidence, have large effects on the more rural coastal area and its inhabitants. In the same way as developments along urbanized coastlines will influence integrity of adjacent rural coastlines, water shed management impacts the long term development of coastal zones, by influencing input of fresh water and sediments. Therefore, resilience of coastal landscapes is only ensured through land-use practices that take into account coastal dynamics, river management and groundwater resources. Regulatory frameworks to ensure this are largely in place in Indonesia and need to be enforced. Participatory planning processes that are part of Coastal Zone Management (CZM) and Integrated Water Resource Management (IWRM) can help to achieve desired objectives and thereby ensure sustainable development of Indonesian coastlines.