Water Pipeline in Sorek, Israel ©Sorek Desalination

Water Production and Transfer Strategies

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KEY FINDINGS

A conceptual approach for developing and evaluating water production and transfer strategies is presented and applied to the project region

12 water strategies were developed. They cover the expected freshwater deficit in 2050. Freshwater supply will rely on seawater desalination along the Mediterranean coast and at Aqaba, Red Sea. The desalinated water will be transported to Jordan and Palestine via a pipe network.

MOTIVATION

The project area, which includes Jordan, Israel and the Palestinian Territories, is characterized by semi-arid to arid conditions and limited natural freshwater resources, suffers from acute water scarcity, which is expected to worsen in the near future. The main regional aquifers have been overexploited for years, resulting in a steady decline of the groundwater levels, and subsequently of the amount of water that can be extracted in a sustainable way. Due to rapid population growth, augmented by the influx of refugees from the adjacent conflict zones, many areas are already affected by acute water shortages. Work conducted under the SALAM Initiative [Future Freshwater Deficits in Palestine and Jordan, p. 18] shows that both Jordan and Palestine will face a serious water crisis unless additional freshwater resources are made available. Israel, on the other hand, has been investing in the expansion of seawater desalination (SWD) since the beginning of the 21st century and will continue to be able to meet the growing demand for freshwater in the future. Cost-effective and implementable solutions are urgently needed to mitigate the emerging regional water crisis. According to the SALAM pilot study (Rusteberg et al., 2019), future freshwater deficits in Jordan and Palestine can only be met by means of SWD in conjunction with water transfer projects. Due to the complexity of the task, the sensitive political context and the preferences at national levels, a conceptual participatory water resources planning approach is needed to develop and evaluate alternative water production and transfer strategies as potential solutions to the freshwater deficit challenge. This Policy Brief shortly presents the suggested approach and summarizes the results of its application to the project region.

METHODOLOGY

Water production and transfer strategies are options for expanding the regional water infrastructure to create a connection, by means of pipeline network, between the prospective SWD Plants and the demand centers. We developed a methodology to identify and evaluate solutions for this water resources planning task. Figure 1 presents the new approach in form of a flowchart containing 10 main planning steps, based on a participatory multilateral decision-making and planning process. The freshwater deficits in the regional demand centers (cluster) in the planning period 2020- 2050 were evaluated on an annual basis by means of water budget calculations [Future Freshwater Deficits in Palestine and Jordan, p. 18]. A baseline scenario was outlined for each country and used for determining the freshwater deficits, assuming that no large-scale interventions in the regional water infrastructure will be implemented in the planning period 2020 to 2050. For each demand cluster, a connection point (CP) for water transfer (existing or planned water reservoir) is identified, from which the imported water can be distributed in the entire cluster. An essential additional step towards the development of water production and transfer strategies was to identify alternative sites for the construction of SWD plants denoted as water production points (PP), both on the Red Sea and along the Mediterranean Sea coast. In order to define a set of potential solutions to the water resources planning challenge, locations and production capacities of the SWD plants are carefully selected in such a way that the projected freshwater deficits of all demand centers for the

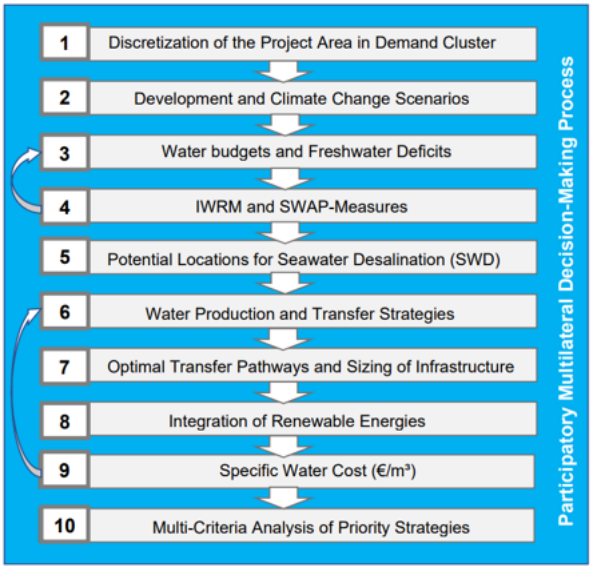

Figure 1: Flowchart – Development and evaluation of water production and transfer strategies

planning horizon 2050 are covered. Increasing the size and capacity of water infrastructure (SWD-plants, pipelines, pumping stations), leads in principle to a reduction of the specific water cost (€/m³). Consequently, a focus was given to planning solutions that rely on large-scale water infrastructure. According to the defined water production and transfer strategies (see Figure 2), optimal routes for water transfer between the potential locations of the SWD plants (PP) and the connection points (CP) of the demand centres are determined and the water infrastructure (pipelines, pumping stations) dimensioned. Infrastructural, political (border), topographical and energetic aspects are of particular importance [Water Conveyance System for Freshwater Deficit Coverage in Jordan and Palestine, p. 37]. The economic and multi-criteria assessment of the alternative water strategies are presented under [Techno-Economic Assessment of Water Infrastructure Projects, p. 72], [Multi-Criteria Analysis of Water Resources Planning Options, p. 80]. More detailed information on the developed conceptual approach for water strategy development can be found in (Rusteberg et al., 2022).

RESULTS

According to water budget calculations [Future Freshwater Deficits in Palestine and Jordan, p. 18], Jordan and Palestine will face a rapidly increasing freshwater deficit, which could be as high as 1.3 billion m³/year by 2050 (712 m3/year in Jordan, 323 Mio. m3/a in the West Bank and 287 Mio. m3/a in Gaza). Following the suggested conceptual approach, we developed 12 alternative water strategies, capable of covering the expected substantial freshwater deficits. All solutions are based on seawater desalination at the Mediterranean and Red Sea and transfer of the desalinated water to demand centres in Jordan and Palestine. Figure 2 compiles the different water strategies, distinguishing between national and regional solutions. Further regional solutions may result from a combination of national solutions. The strategic linkage between water production points and demand centers is presented by arrows, indicating the required water production and transfer in Mio. m3/a of desalinated seawater. The strategies are numbered according to production points (PP) which refer to the SWD plants. The desalination facility near to Netanya (PP-1) exploits the close vicinity to the Palestinian demand areas in the northern Westbank. Similarly, the potential expansion of the SWD facility near to Ashdod (PP-5) exploits the relatively small distance to the Palestinian demand areas in the southern Westbank. This is an important aspect, since land use rights may significantly complicate the construction of a transfer pipeline on

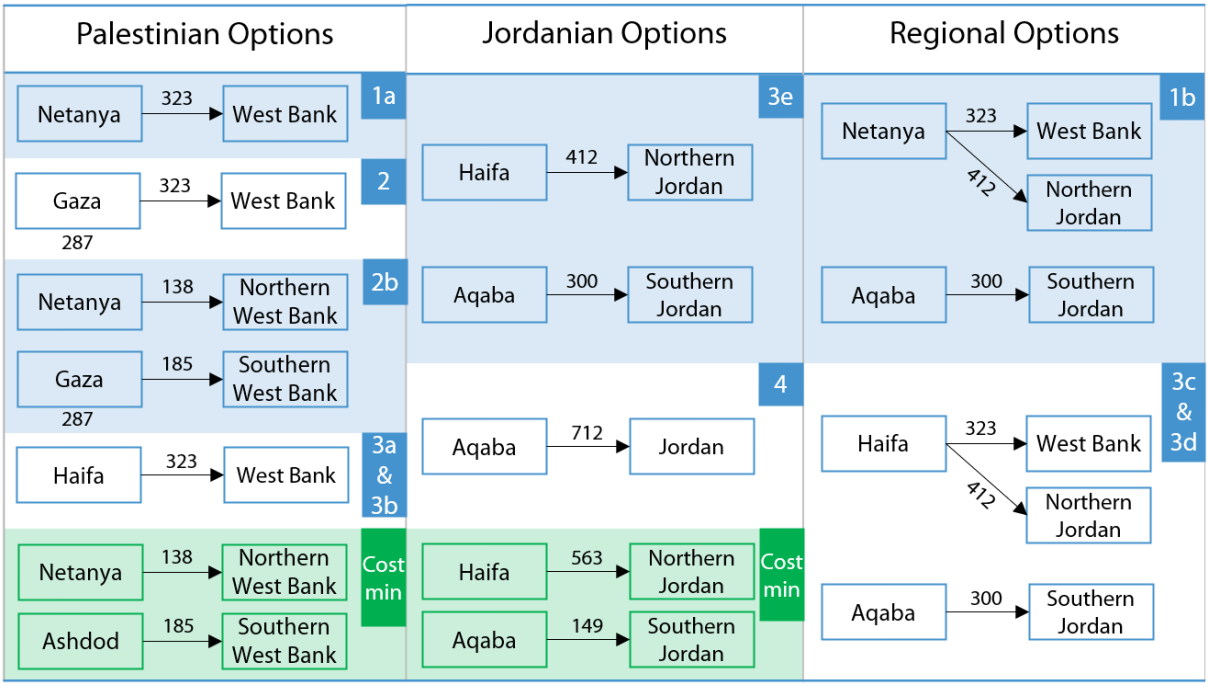

Figure 2: Water production and transfer strategies – planning horizon 2050

Figure 3: Regional water strategy, constituted of the national strategies 2b (Westbank) and 3e (Jordan)

Israeli territory. Regardless of water transfer considerations, the Gaza Strip will rely on the SWD to meet its freshwater needs (PP-2). Alternatively, a water transfer from Gaza to the West Bank is also being considered, as Palestine associates it with greater independence from Israel in terms of water supply. Shavei Zion (PP-3), north of Haifa Bay, has been considered as another potential site for the construction of a large SWD plant due to its proximity to the Lake Tiberias (Sea of Galilee). The produced water could then be transported by gravity via a tunnel to the Lake Tiberias which would act as regional large-scale storage and regulating facility. Furthermore, hydropower may be generated at Lake Tiberias by exploiting the topographic drop between the Mediterranean Sea and the lake [Large-Scale Hydropower Plant at Lake Tiberias in the Context of Transboundary Water Transfer, p. 50]. Furthermore, Aqaba (PP-4) is available as a potential site for SWD, being located on the only Jordanian coastline. [On- and Offshore Solutions for Large-Scale Seawater Desalination at the Mediterranean Coast, p. 26] and [Renewable Energy for Seawater Desalination in the Middle East: Case Study Aqaba, Jordan, p. 30] provide further information on the implementation of SWD plants in the region, taking also offshore solutions into account. Finally, a cost-minimal solution (green colour) could be developed by a non-linear cost minimization model [Regional Macro-Model for Transboundary Water Resources Planning, p. 76]. Figure 3 shows a regional water strategy combining the Palestinian strategy 2b with the Jordanian strategy 3e. This solution considers the expansion of the Gaza SWD plant (PP-2) to cover the water needs of Gaza and the south of the Westbank, while the North of the Westbank is being supplied from Netanya (PP-1). In accordance with the current plans of the Jordanian Government, 300 Mio. m3/a of desalinated seawater will be produced at Aqaba and transferred to southern and central Jordan. The remaining freshwater deficit of 412 Mio. m3/a in North and Central Jordan is covered by the above-mentioned "Haifa-solution"(3e). Figure 4 presents the regional water allocation network, used as basis for cost minimization studies [Regional Macro-Model for Transboundary Water Resources Planning, p. 76], which is an overlay of all alternative planning solutions, taking the optimal water transfer pathways into account.

CONCLUSIONS

The development of expansion variants of the regional water resource system to cover the freshwater deficits in the project region is a water resources planning task. Its solution requires, partly due to the sensitive political context, a structured participatory approach to ensure transparency and thus acceptance of the results. Based on the suggested conceptual approach, it was possible for the first time to provide implementable water production and transfer strategies to solve the freshwater deficit problem in the region. All strategies are based on seawater desalination at different locations on the Mediterranean Sea as well as the Red Sea and a combination of water transfer projects. The project work on individual steps of the approach, such as the water budget calculations, the design of the SWD plants, the optimal routing between the plants and demand areas, the cost calculation, the integration of renewable energies as well as the multi-criteria analysis of alternative strategies are detailed in other policy briefs in this brochure. Due to its general structure, the approach can also be applied to neighbouring countries or other regions that face similar problems and which need to rely on desalination and water transfer in the future (e.g. Egypt). The results show that transboundary cooperation between Israel, Jordan and Palestine is needed to solve the water deficit problem and avoid a further extension of the emerging water crisis in the region. In view of the region´s rapidly increasing freshwater deficits, there is an urgent need for action regarding the implementation of a jointly supported regional water strategy. Further recommendations towards strategy implementation will be provided under [Assessment of Freshwater Strategies and Recommendations for Implementation, p. 92].

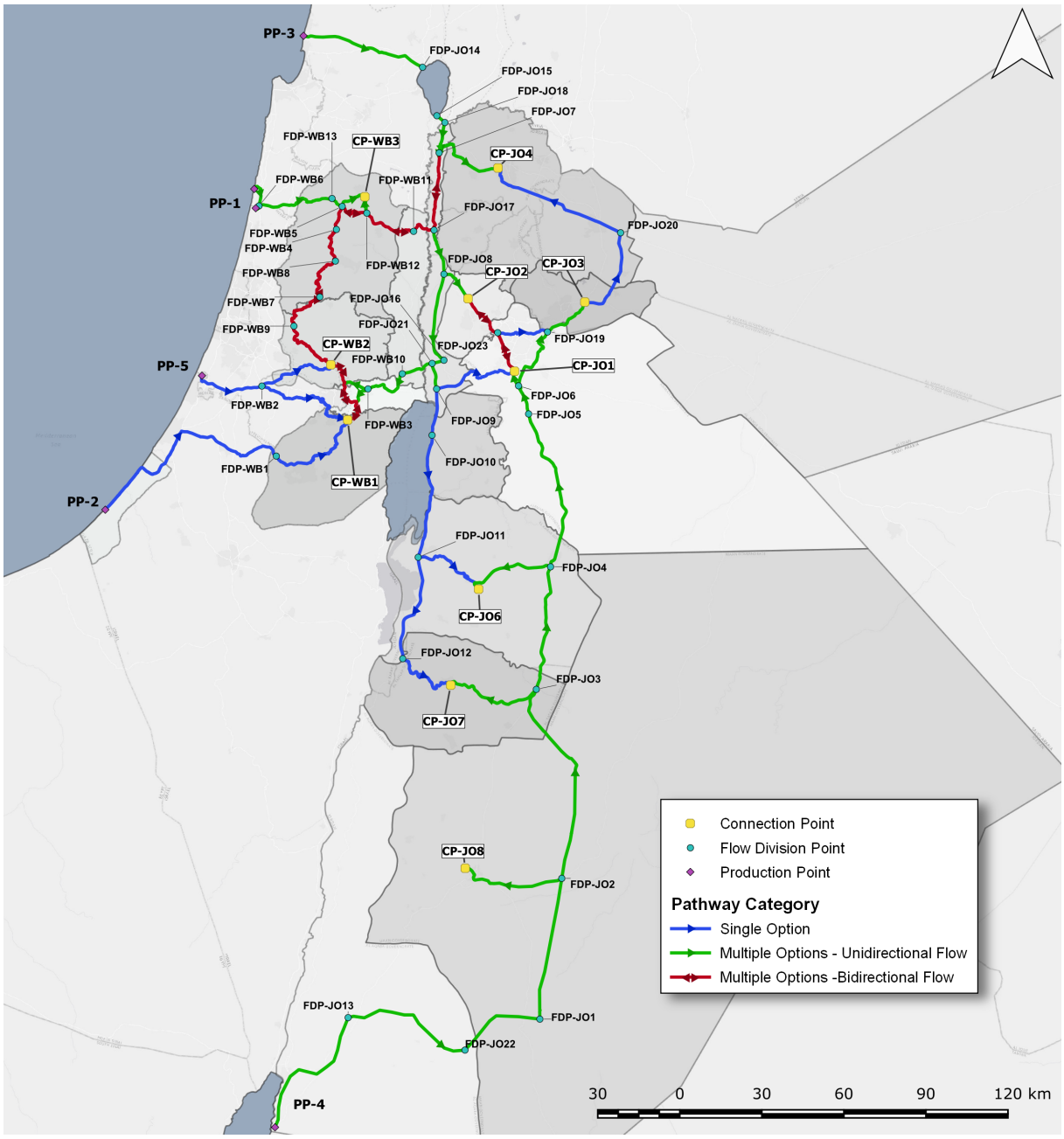

Figure 4: Regional water allocation network as overlay of all water production and transfer strategies, based on the optimal water transfer pathways

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