KfW Development Bank

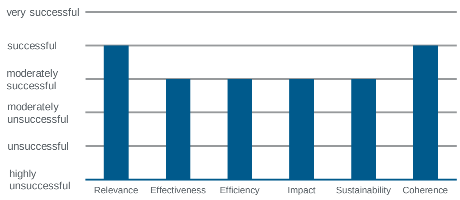
Ex-post evaluation Hydrological and Meteorological Monitoring, Jordan

Title	Hydrological and Meteorological Monitoring System Support Project
Sector and CRS code	Preservation of Water Resources (1401500)
Project number	2011 97 755
Commissioned by	BMZ – Federal Ministry for economic cooperation and development
Recipient/Programme executing agency	Hashemite Kingdom of Jordan / Ministry for Water and Irrigation (MWI)
Project volume/ Financing instrument	6.4 million Euro / FC grant
Project duration	*2021-2020*
Year of report	2025 | **Year of random sample** | 2022

Objectives and project outline

The objective at the outcome level was to improve water resource management and reduce the vulnerability of the Jordanian population to the impacts of climate change (impact) through the permanent availability of hydrological and meteorological information. The project invested in the collection, transmission, and consolidation of data from hydrological measuring stations to be installed or rehabilitated nationwide as a planning and investment basis at the central level (MWI).

Overall rating: **moderately successful**



Key findings

The project addressed the core issue of the Jordanian Ministry of Water and Irrigation (MWI) with high relevance and coherence, which was the lack of reliable data (groundwater, dams, wadis, weather) from measuring stations, thus lacking a solid foundation for effective water resource management. Although almost all stations in the project context could be equipped with telemetry, raw data collection at various stations was inconsistent and incomplete. Nevertheless, the project is rated as "moderately successful":

- The project was aligned with the global, regional, and country-specific policies and priorities of Jordan and BMZ, and contributed to the institutional strengthening of the Ministry of Water and Irrigation. (Relevance)
- The project measures led only to a limited extent to the desired permanently available and reliable hydrological and meteorological information, as measurement data on groundwater and dam levels could not be fully captured, and other data were partially incomplete. (Effectiveness)
- The highly ambitious project goals could only be partially achieved, as a database was established, but the raw data source and transmission only provided an incomplete information basis, which subsequently limited the potential impacts. (Impact)
- As successes of data provision on a central basis, the project recorded a structured database and trained personnel in the ministry (MWI). Only with appropriate financial resources (budget) can sustainable maintenance of the telemetry-equipped measuring stations be ensured. (Sustainability)

Conclusions

- The project strengthened the central role of the Ministry of Water and Irrigation through the availability of a database of hydrological and meteorological measurement data.
- The coordination between technical cooperation (TC) and financial cooperation (FC) was considered important and beneficial by the partners.
- Focusing on strategically important and priority measurement stations is advisable for potential follow-up projects.
- Groundwater measurement stations require a special budget item for maintenance work (follow-up drilling when levels drop) and should be factored into follow-up projects.

Ex-post evaluation - assessment according to OECD DAC criteria

Overview of the rating per criterion:

Relevance	2
Coherence	2
Effectiveness	3
Efficiency	3
Overarching developmental impact	3
Sustainability	3
Overall rating:	**3**

Abbreviations:

BGR	Federal Institute for Geosciences and Natural Resources
BMZ	Federal Ministry for Economic Cooperation and Development
DAC	Development Assistance Committee
FC	Financial Cooperation
FC E	FC Evaluation
GDP	Gross domestic product
HDI	Human Development Index
JVA	Jordan Valley Authority
MWI	Ministry of Water and Irrigation
M&E	Monitoring & Evaluation
PA	Project appraisal
PAR	Project appraisal report
PCR	Project completion report
TC	Technical Cooperation
WAJ	Water Authority of Jordan
WIS	Water Information System

General conditions and classification of the project

Water scarcity in Jordan is among the greatest worldwide posing significant developmental challenges for the country. The first National Water Master Plan (1974) already addressed usage conflicts between households, irrigation agriculture, and industry. Subsequent national water strategies (1997, 2008, and 2016) all emphasized reliable and transparent data exchange in the water sector as a basis for planning security for efficient water allocation in the country. The population, which quintupled between 1974 and 2020, and the still high consumption in irrigation agriculture, coupled with measurably declining water availability, have further strained the natural water resources. Seawater desalination and the use of treated wastewater have been part of strategy and investments for more than 10 years to increase water supply and address usage conflicts. The Ministry of Water and Irrigation (MWI), founded in 1988 as the political anchor of Jordanian water policy, has not been able to significantly counteract the growing water stress in the country. The Jordan Valley Authority (JVA), established in 1977, and the National Water Authority (WAJ), created in 1982, have been embedded in the MWI since 1988. They focus their activities on irrigation agriculture (JVA) and, as a holding company (WAJ), on the main supply areas of Greater Amman (Miyahuna Water Company), Northern Jordan (Yarmouk Water Company), and Southern Jordan (Aqaba Water Company). All institutions collect, store, and use data for their own purposes, mostly obtained manually from their measuring stations. The project located within the MWI aimed to strengthen its role as a central actor under complex institutional conditions with a consolidated database.

Brief description of the project

The project "Hydrological Monitoring Network," implemented between 2012 and 2020, is part of Jordan's efforts to consolidate, process, and utilize reliable data from approximately 870 measuring stations nationwide (including weather data and groundwater levels) at the central level (AMWI) for planning and investment decisions. The project focused on the use of telemetry at over 140 stations managed by the MWI, some of which were newly installed, to ensure smooth data transmission to a central location within the MWI. Stations already equipped with telemetry were upgraded as part of the project. Construction services were commissioned and monitored to enable the collection of groundwater data. The structuring of the database, data streams, and data processing for institutional uses, as well as the procurement of hardware and software for a central unit within the MWI, and training were also implemented. The project complements various technical cooperation measures (BGR, GIZ) and measures from other financiers (USAID) to contribute to improved water resource management in Jordan. The total cost of 6.6 million EUR was financed from budget funds (6.4 million EUR) and own funds (0.2 million EUR). The funds were fully disbursed and used according to the agreed contract contents.

Breakdown of total costs

In EUR million	**Investment costs (plan)**	**Investment costs (actual)**
Total costs	**6.6**	**6.6**
Own contribution	0.2	0.2
External financing	6.4	6.4
of which budget funds (BMZ)	*6.4*	*6.4*

Map of the project country incl. project areas

Figure 1 – Weather measuring stations (highlighted in green: newly constructed by project)

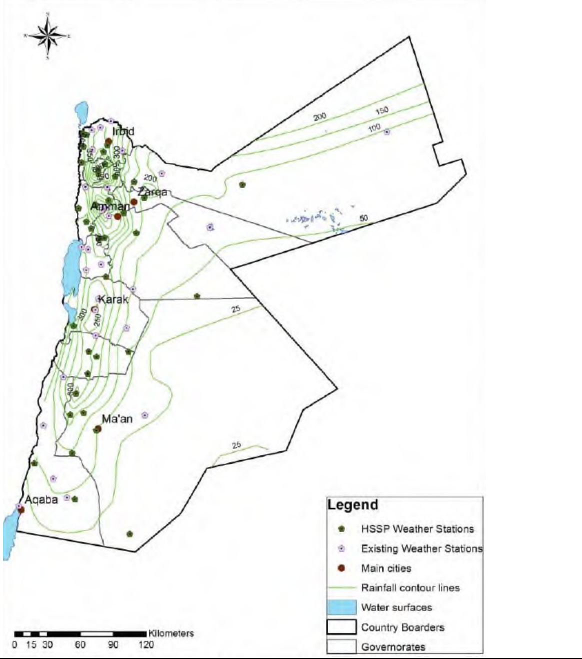


Figure 2 – Rain measuring stations (highlighted in purple: newly constructed by project)

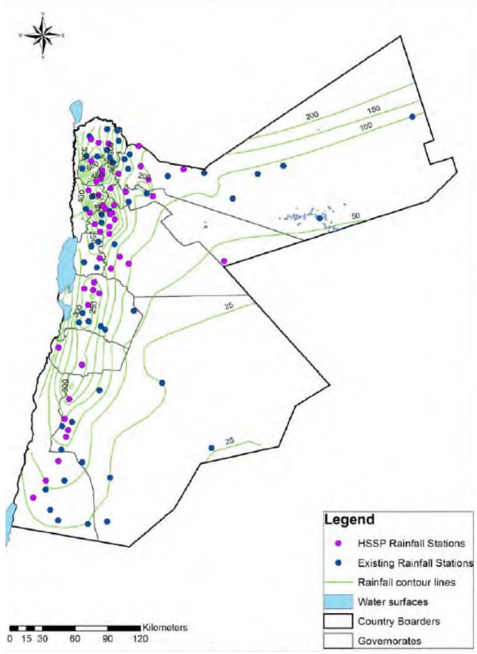


Figure 3 – Ground water measuring wells (highlighted in dark blue: newly constructed by project)

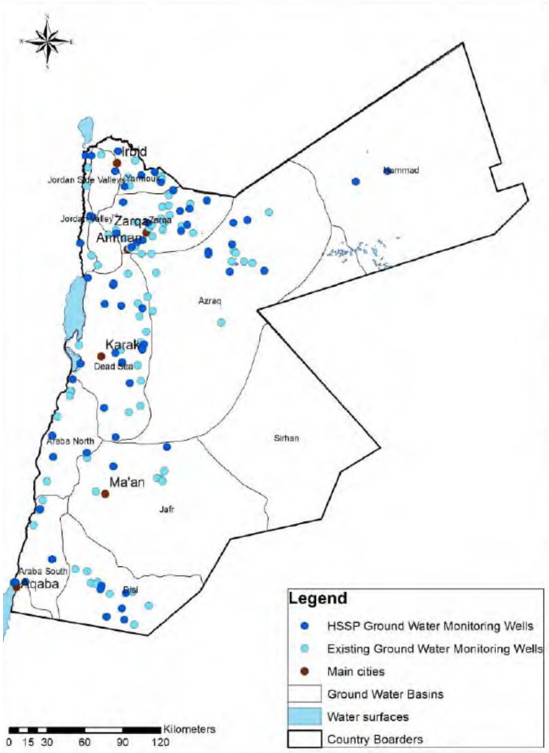
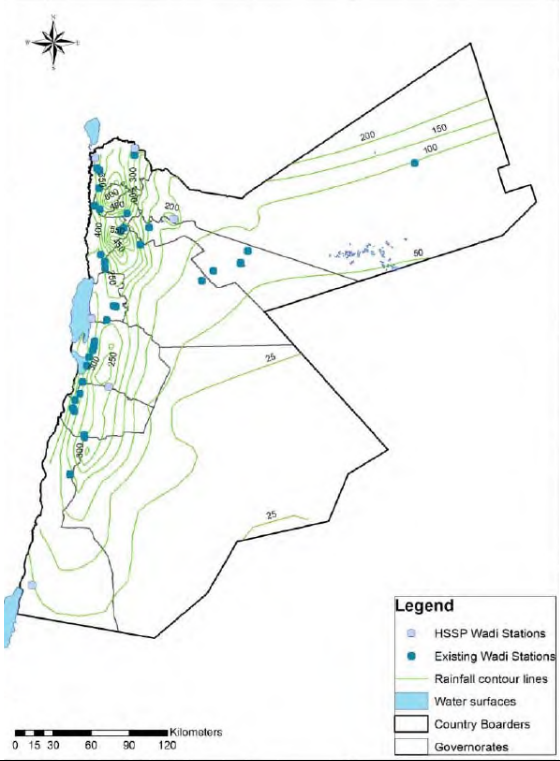


Figure 4 – River level measuring points (highlightd in light blue: newly constructed by project)



Source: Dornier Consulting International GmbH

Rating according to OECD DAC criteria

Relevance

1. Alignment with policies and priorities

Jordan is one of the countries with the lowest renewable water resources worldwide. Over the past decades, water availability per capita has steadily declined, now reaching values five times lower than the so-called water poverty threshold of 500 m³ per capita per year. The mere availability and storage of water, as well as knowledge about the stock and availability of water resources, have been strategic topics since the publication of the National Agenda in 2005. Building on this, the Water Strategy 2008-2022 was developed with the goal of eliminating water deficits by 2022. To achieve this, extensive institutional reforms paired with infrastructure investments (Disi aquifer, seawater desalination) were announced and planning was implemented.

In the wake of these reform announcements and building on initial positive experiences with telemetry applications at approximately 20 measuring stations (Federal Institute for Geosciences and Natural Resources (BGR) and GIZ) and a "Data and Information Management" component of a technical cooperation water program (2011-2014), the financial cooperation project conceived in 2012, with the support of over 140 measuring stations, represented an important addition to provide reliable and consistent hydrometric data centrally at the MWI. The project thus took up Jordanian reform efforts and was in line with the goals of the Jordanian-German development cooperation.

The project was initiated at a time when the MWI assumed the political and institutional role of establishing a larger planning basis for water issues while also managing the influx of Syrian refugees into Jordan from 2011 onwards. Priority action areas were to meet the immediately growing water demand and to address the increased non-revenue water (approximately 50%). A large part of the existing inefficiencies was structurally related (insufficiently maintained infrastructure, lack of data) and due to illegal connections as well as inadequate billing and recording processes.

2. Alignment with the needs and capacities of the beneficiaries and stakeholders

The goal of the Hydromet project was to reduce the vulnerability of the Jordanian population to the impacts of climate change through the availability of reliable hydrological and meteorological information. The core issue identified during the project evaluation (July 2012) was that users at the central level did not have access to reliable data to generate information for the operational or strategic level of planning, decision-making, and implementation of measures and actions.

The immediate users are primarily located at the central level within the MWI, and the project is hosted there as the place of greatest institutional and systemic relevance. As the central organ of water policy with important regulatory tasks, strengthening its capacities was a central concern of the project. According to the implementation agreement, a steering committee equipped by key institutions under the leadership of the MWI was to take on a coordination role to manage important implementation steps. The main stakeholders and other data users (WAJ, JVA, Meteorological Service) were to be actively involved in the project either through data and information exchange or IT support, or exchange information (Royal Geographic Center, Ministry of Agriculture) with the MWI and its departments responsible for project implementation.

An implementation consultant was located within the MWI's implementation unit, which primarily carried out activities at the operational level. Their tasks focused on equipping measuring stations with telemetry and establishing suitable transmission paths and a suitable database structure. A desirable, more strategically oriented consultancy was not feasible for the implementation consultant, although some considerations were made in this direction—particularly regarding which data are relevant for questions of vulnerability and political decision-makers.

The consulting services were also intended to strengthen the capacities at the personnel level of the MWI with regard to the technical use and maintenance of the measuring stations. In this respect, the proposed concept was adapted to the institutional conditions and needs.

3. Appropriateness of design

With the objective of strengthening the MWI as a central player in the water sector, the core approach of the project was indispensable. The challenging goal at the outcome level, to permanently access relevant and reliable information to better manage water resources and thus reduce the population's vulnerability, was difficult to achieve given the precarious condition of the measuring stations. After extensive diagnostics, equipment planning, and performance description for the implementation of investment measures along with the operational concept, it might have been advisable to focus the project measures on a smaller number of measuring stations.

Overall, compared to the initial state, the number of telemetry-equipped measuring stations was doubled by the financial cooperation project, although not all are functioning satisfactorily. The concept of establishing a data center within the MWI that accesses data from multiple stations, transmits data to various users in different institutions, and thus becomes part of the water information system was entirely plausible. Instead of the term "control room," "data room" or "shared data room" could have been used to document to other institutions that such an endeavor can only succeed through the collaboration of various actors.

Given the enormous challenges of obtaining raw data and the technical limitations of telemetry applications, a more transparent discussion of the advantages and disadvantages of manually measured and documented data versus telemetry-measured and transmitted data at some stations would have been desirable beforehand. Additionally, answering the question of which data and stations within the existing and newly installed network are strategically crucial to obtain and transmit data was important. It is unclear to what extent a broad discussion took place at the central decision-making level, including the steering committee.

The development of a guideline that provides the MWI with a decision basis for certain types of measuring stations under different environmental conditions and operational aspects was not planned within the project. Furthermore, as a learning experience, it should be mentioned that vandalism as a risk factor should be more strongly considered in the choice of location and equipment of measuring stations.

4. Adaptability – response to change

It became apparent that the systematic handling of comprehensive telemetry data from approximately 300 stations (143 stations were to be newly constructed and equipped with telemetry, 30 additional stations were to be rehabilitated or relocated, and 133 other stations were already more or less well equipped with telemetry) posed a challenge for the responsible parties in the ministry. An adjustment of the consulting services was therefore necessary and implemented. However, it should be noted that the original concept already included an inventory at the beginning of the project, which could potentially impact the design of the project. In this respect, the potential need for rehabilitation was anticipated.

In addition to purely technical and operational aspects (fixed maintenance protocols and intervals, routine replacement investments, e.g., for batteries, renewal of SIM cards for data transmission), extensive drilling services had to be defined and tendered to obtain data on groundwater levels and thus upgrade the relevant stations. Due to the declining groundwater levels (several meters per year), the existing measurement wells were no longer deep enough to measure water levels. Originally, negligible investments in groundwater drilling were assumed, but a significant portion of the available project funds had to be used to upgrade the measurement wells. Consulting services were expanded to create performance descriptions and oversee drilling measures. Numerous drillings were implemented at the considered locations to ensure sufficient data could be measured by the project's completion.

Rating summary

The project was very well aligned with policies and priorities, as well as the needs and capacities of the stakeholders involved, but not with the actual condition of the existing measurement infrastructure.**Relevance: successful (2)**

Coherence

5. Internal coherence

Between 1990 and 2022, several collaborations and projects took place between Jordanian and German institutions regarding data collection and storage to provide information for more holistic water management planning, without delving into the long approximately 40-year history of Germa-Jordanian cooperation in the sector. The Water Evaluation and Planning System at the MWI was supported by BGR and GIZ. The data obtained from the evaluated project are also intended to contribute to the development of the "National Master Water Plan" supported by technical cooperation.

Starting in mid-2013, workshops and smaller working group meetings were conducted between various institutions and stakeholders as part of the advisory services of the project. Additionally, working sessions were held to promote the exchange of criteria and decisions on where stations should be equipped with telemetry and where drilling should take place. In this sense, the MWI organized exchanges between various technical cooperation projects conducted within the ministry.

The varying intensity of exchange and commentary on investment plans from the financial cooperation project for the use of telemetry in various stations nationwide occurred particularly with two technical cooperation projects: the "Management of Groundwater Resources" project implemented by Jordanian partners and BGR (BMZ-No. 2014 24 795) and the "Management and Water Resources" project implemented by MWI and GIZ (BMZ-No. 2014 24 787). While the former focused on strengthening the MWI's capacity to process and evaluate hydrological data for groundwater resource management, the latter focused on strengthening the MWI in sustainable water management planning. Follow-up projects for capacity strengthening of the MWI are being implemented in both areas.

Despite incorporating experiences and concepts on some critical technical questions of the project (critical review of the telemetry network, advantages and disadvantages of manual data transmission versus telemetry, operation and maintenance of existing facilities at new stations), agreement could not be reached on some issues (station location choice, operational aspects). A stronger networking of learning experiences and clear coordination among core institution participants, with regular coordination by a steering committee, could have reduced recurring discussions during the project duration.

6. External coherence

In addition to the German actors outlined in the "internal coherence" section, a variety of national and international actors were involved in the collection and use of hydrological data. The multi-year Water-Al-Location system was developed by scientists from Israel, Jordan, and Palestine. At the time of the project evaluation, the establishment of a Water Information System (WIS) was discussed, which was developed within the framework of the Union for the Mediterranean (2013). Prospectively, the data collected through the project measures are intended to be integrated into the WIS.

Given the apparent institutional fragility at the beginning of its implementation, the project was able to mobilize the key actors at the central level, focusing on telemetry and strengthening the IT structure. The MWI assumed its role as the central decision-making authority. However, broader involvement, including at least WAJ, JVA, the Jordanian Meteorological Service, and the Ministry of Agriculture, would have been desirable to establish a more robust basis for investment decisions and a greater opportunity for networking measuring stations among different stakeholders.

From a technical standpoint and within the framework of the project's implementation, all services were carried out according to the original concept regarding sponsorship, procurement, and service delivery by competitively selected contractors. The planning and service delivery were fully embedded in the Jordanian institutional context. The structures of the sponsor were utilized, and the capacities of the sponsor and other institutions involved in the project implementation were strengthened.

Rating summary

The project is characterized by high internal and external coherence. Given the strategic ambition of the project, the introduction and consolidation of a broadly anchored steering committee might have resulted in a more effective contribution from the project.

Coherence: successful (2)

Effectiveness

7. Achievement of (intended) objectives

The project goal defined during the project appraisal at the outcome level was "Through the permanent availability of relevant and reliable hydrological and meteorological information, the vulnerability of the Jordanian population to the impacts of climate change is reduced and the management of water resources is improved." From the perspective of the ex-post evaluation, the goal of reduced vulnerability/increased resilience is more appropriately situated at the impact level, as the mere availability and use of hydrological and meteorological data do not directly result in increased resilience of the target population. For this to occur, it is necessary that targeted investment management and ultimately efficient nationwide water management are based on the data. Only on this basis would a stable and secure supply of water to the target population be achieved, which would increase their resilience to the impacts of climate change (impact level). This aligns with the outcome indicators defined in the project appraisal. These indicators address data availability, but not the vulnerability/resilience of the population, which is therefore considered in the evaluation under the "Impact" chapter.

As indicators at the outcome level, it was established that relevant and reliable hydrological data are available to political decision-makers, the Jordan Meteorological Department, consultants, and the scientific community. Unavailable and undistributed information was identified as project risks.

The achievement of the goal at the outcome level can be summarized as follows:

Table Target achievement Outcome:

Indicator	Status at PA	Target value according to PA/EPE	Actual value at PCR (optional)	Actual value at EPE
(1) Improved data collection: Number of functional stations with telemetric data transmission	128	>250 (122 new)	230 out of 298 (thereof 123 emanating from this project) Partly achieved	230 (not all collecting complete data). Nearly all new stations functional (weather stations) Partly achieved
(2) Improved data transmission	80 %	<95 %	Based on 4 out of 26 parameters: 89 % (overall) 99 % (excluding vandalism) Partly achieved	Between 80 % and 95 % for parameters like temperature, downfall, wind speed and direction. Less than 80 % for parameters like water levels and flow rate
(3) Improved data processing: accuracy of meteorological data collected by MWI	97	>99 %	Based on control measurements: 99 % (excluding measuring wells and dams) Partly achieved	Under 97 % for 296 stations and 142 stations with new telemetry

(4) Improved monitoring: target group (decision makers, meteorol. service, science, consultants) has access to data and pertaining assessments	Yes	Yes	Yes	Based on report formats and demand-based No web-based platform (for general public) Achieved

8. Contribution to the achievement of objectives

The project's investments focused on linking raw data with a database (control room) through specific interventions (IT, field instruments, drilling). These interventions aimed to collect raw data (such as groundwater levels through drilling), calibrate stations, install telemetry at selected hydrological and meteorological stations nationwide, enable data transmission and storage, and provide data at a central location (control room) within the MWI.

Following the assessment of station conditions, MWI, WAJ, JVA, together with the implementation consultant, decided to largely utilize the existing measurement network, rehabilitate where possible, and establish new stations equipped with telemetry. Various methodological discussions took place regarding the physical and organizational concept, quality parameters, location, number of stations, and influencing factors of certain stations (topography for rainfall stations, residual saturation thickness of watercourses for groundwater monitoring, etc.). Challenges arose at all station types (weather, rain, groundwater, dry valleys (wadis), surface water) to collect, transmit, and process data.

Data Collection:

At the beginning of the project, many groundwater measurement wells were already dried up (another indication of widespread declining groundwater levels across the country), and parts of the weather stations were damaged or no longer operational. This situation required reallocating financial resources to ensure data collection of certain measurements, particularly groundwater-related data, and occasionally data from dams and wadis. Approximately 40% of the total project costs were spent exclusively on drilling, construction, and testing of groundwater wells. Some weather stations required extensive calibration work. The evaluation mission results showed that most groundwater stations did not transmit data correctly, as groundwater levels dropped faster than anticipated, rendering sensors inoperable. Corrections in calibration were proposed and made at weather stations (wind speed, humidity sensors). In some locations, a less representative site (such as the roof of a multi-story building) was chosen over a potentially vandalism-threatened site to ensure safe, continuous, and long-lasting data collection and transmission.

Data Transmission:

Data transmission depends on whether the devices are operational (battery, SIM card) and whether sufficient communication between the transmitter and home base is established. Key elements of a well-functioning data transmission structure include enabling (remote) updates, having sufficient data storage, retention, and durability, sending messages with time series data, and confirming successful storage. Additionally, an appropriate rule or inference engine (responsible for processing all types of incoming data and events) should be accessible. Overall, a good basis for transmission was developed during the project, provided batteries and SIM cards were installed and available.The poor data transmission record in the project context is explained by the lack of raw data source collection for groundwater, wadis, and occasionally dams. The continuously declining groundwater levels complicate the installation of suitable measuring devices, creating a high demand for deep drilling and requiring prioritization of strategically relevant sites.

Data Processing and Preparation:

Processing data to generate meaningful information requires a certain standardization of reports or templates and specific specifications from data users. On the other hand, data must be structured, assignable, and temporally sequenced for preparation and querying. The software and hardware used in the project enable data preparation and processing. The control room at the MWI is utilized, and data queries are made by users (MWI, JVA, WAJ, Meteorological Service, universities, consultants). A web-based data access for the public is not available.

The control room is located on the ground floor of the MWI, accessible to the public upon registration with the MWI, and allows data visualizations of all kinds (various widgets) on large wall screens. The structure is designed to respond to real-time data from devices, and usage rights can be assigned to users to improve data security.

The accuracy of the data available in the database and measured and transmitted by the stations is below the originally set high target value of at least 99%. A comparison of manually collected and telemetry-transmitted data showed a match of more than 98%—provided comparable data were available. However, there are stations with non-measurable raw data, stations damaged by vandalism, and stations at unsuitable locations. Thus, the very ambitious target value was not achieved. Fundamentally, there is a good working structure that needs to be supported by appropriate institutional measures to institutionalize raw data collection permanently (see sustainability).

Reporting and Quality Control:

Reporting must consider institutional requirements and individual user requirements, as well as their roles, which require specific report formats and frequency. Control room staff at the MWI regularly receive different data query requirements, occasionally from other institutions and universities. MWI staff report that data from the project-created database are included in planning documents of the ministry and other stakeholders.

The EPE results show that data from the control room are used by the MWI, standardized queries/forms, and other types of reports are completed and serve as input for the water information system. A protocol for regular quality checks of data transmissions or a deployment plan for quality control or maintenance of measuring stations by control room staff or ministry operations and maintenance personnel could not be provided. On-site inspections of measuring stations are usually based on obvious disturbances for problem-solving. Control room staff report that users from other institutions, JVA, WAJ, and universities collect data on a rather irregular basis. The groundwater and surface water department of the MWI collects data from stations with manual data transmission, such as from JVA. Regarding the institutional recognition of centralized data processing within the MWI, the EPE results show a fairly strong data basis at the MWI, as data from other institutions also flow into the WIS. However, other institutions (JVA, WAJ, Meteorological Service (Jordan Meteorological Department), and the Ministry of Transport) continue to maintain their network and manage their own database. The creation of a single, overarching "backbone" of an accurate and solid database with water-related measurements could not be implemented by the project. On the other hand, the water information system is considered the largest civilian database of various measurement points in the country.

9. Quality of implementation

Starting from the project conception in mid-2012 to the international tendering and commissioning of the implementation consultant from August 2013, the MWI was able to quickly utilize the services of the implementation consultant. The construction services and procurements (equipment and IT) were tendered according to financial cooperation standards, and overall, service providers (international and Jordanian companies) with high-quality work were commissioned.

The available project funds were fully expended, and the services provided led to the institutional use of data to provide information, depending on data quality. In this respect, one can speak of an implementation success. On the other hand, the lack of data reliability in terms of the desired indicators for achieving the goal remains a significant and unresolved problem for certain measurements across the broad thematic range of measuring stations.

It was noted that from the second year of project implementation, with the determination of the stations to be equipped and their networking with the central database, a significant effort was required to mobilize the operational units of the ministry, which were numerically weak in personnel, accompanied by the services of the implementation consultant. The consultant supported the MWI in tenders and was also flexibly deployed for necessary adjustments in activities (e.g., drilling for groundwater observation wells). The consulting services also strengthened the capacities of the MWI personnel responsible for maintenance, which was evident during the evaluation through the secure handling of routine tasks at the measuring stations during field visits.

10. Unintended effects (positive or negative)

No unintended negative effects are noticeable. Unintended positive effects were identified in specific instances, as institutions not affiliated with the MWI (Ministry of Agriculture, universities, schools) occasionally performed minor cleaning tasks at MWI stations during manual measurements at their stations or reported deficiencies to the MWI maintenance unit.

Rating summary

Based on the provision of reliable data to a central location and given the strong support of the project at the central level within the MWI, the establishment of an open and consolidated database for different users, fed by nationwide distributed measuring stations, the project is overall still considered partially successful in terms of achieving the indicators at the outcome level (effectiveness).

Effectiveness: moderately successful (3)

Efficiency

11. Production efficiency

The consulting costs of the project, accounting for 40% of the total project, are quite high. However, given the challenging services and work on-site and the complex institutional framework conditions, this proportion is considered understandable. Delays in tendering procedures, bureaucratic obstacles in importing goods, and the extensive monitoring of work at some measuring stations led to an extension of the implementation duration of the measures (planned: 5 years) by approximately one year, including consulting services.

The remaining approximately 60 % of the total costs were spent on drilling work (contract worth 2.6 million EUR), field instruments (contract worth 1.1 million EUR), and IT work (contract worth 0.2 million EUR). A total of 142 stations (weather: 32, rainfall: 39, groundwater: 56, wadi: 7, dam: 8) utilized the supply, installation, connection, and commissioning of investments based on telemetry. The cost-intensive drilling of 22 boreholes and the rehabilitation of 11 boreholes, as well as nine pump tests, accounted for 40% of the total budget. This left only about 20 % of the project funds for instrumentation and IT, shifting the financial focus of the project away from telemetry-related measures. However, obtaining raw data of sufficient quality and quantity is the foundation for later data use, making this approach logical. At the same time, the high dependency on donor-funded investments for fundamental measures to monitor groundwater levels becomes apparent.

12. Allocation efficiency

To evaluate the relationship between input and impact, the (non-quantifiable) increased resilience of the Jordanian population to the impacts of climate change would need to be compared to the project measures, which is not possible in a meaningful way. However, allocation efficiency can be positively assessed, as the availability of reliable hydrological and meteorological data is a fundamental prerequisite for effective water resource management and thus appears indispensable. The transmission of this information via telemetry devices, as advanced by the project, is plausibly more efficient in the overall context than manual transmission. Therefore, the allocation efficiency of the project is rated positively.

From an efficiency standpoint, the coordination and collaboration with other data-driven projects in the Jordanian water sector (see section on coherence) should also be considered and positively assessed. From today's perspective, there were no more cost-efficient alternatives to the measures carried out. The commissioning of an implementation consultant with the necessary expertise for planning and construction supervision services, combined with international procurements, was also essential.

Rating summary

Given the significant adaptation requirements, the construction measures to be undertaken, and numerous field visits during the conception, implementation, and follow-up phases, the specific costs of the project and consulting measures are overall still considered reasonable. Taking into account the delayed implementation, the efficiency is rated as moderately successful.

Efficiency: moderately successful (3)

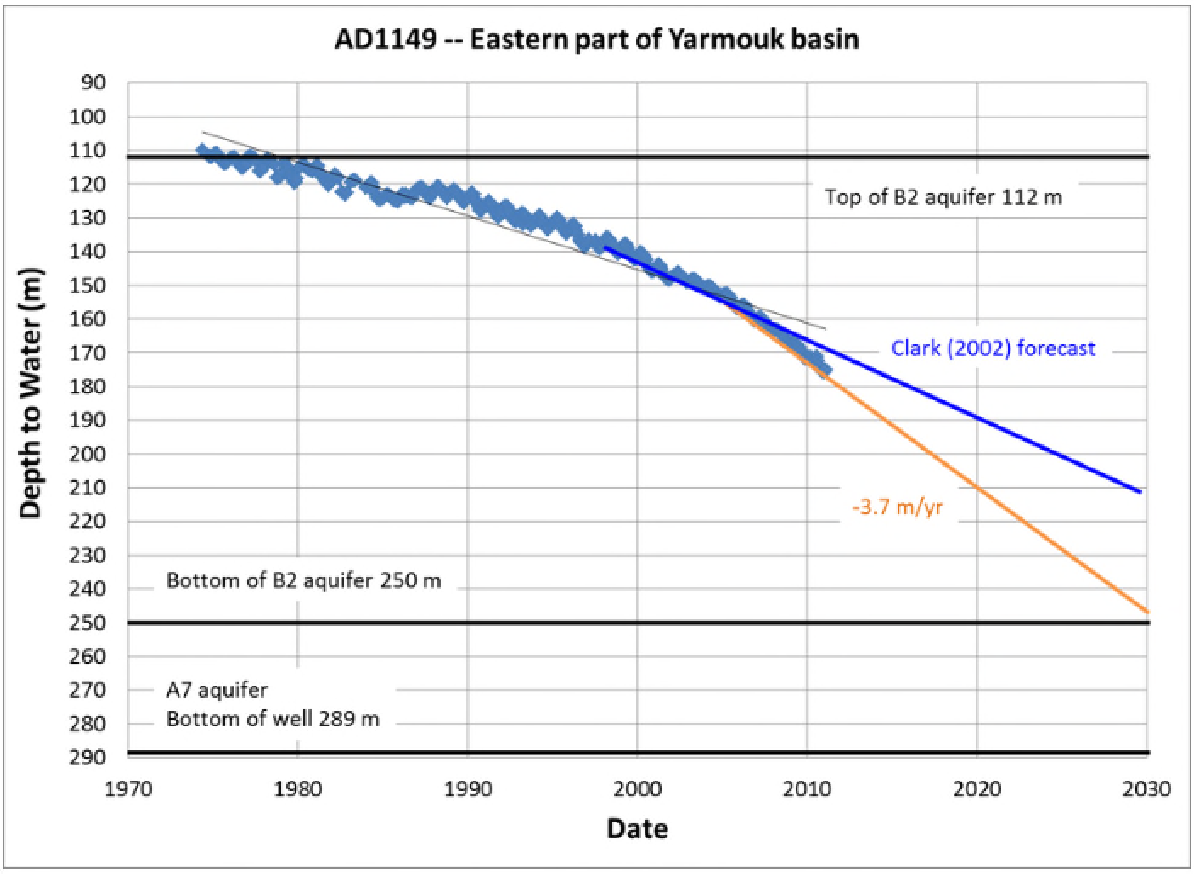
Overarching developmental impact

13. Overarching (intended) developmental changes

The water supply situation in Jordan, measured by the usual indicators (access to safe drinking water/access to safe sanitation), has remained stable at a high level (99 % and 82 % of the population, respectively) over the past 15 years. However, it should be noted that this does not imply a 24-hour supply. Even in the Greater Amman area, the connected population is supplied only two days a week.

The currently stable supply situation must also be viewed in the context of the constant overexploitation of groundwater resources in Jordan, resulting in a continuous decline in groundwater levels. To illustrate, the following diagram shows the development of the groundwater level in the Yarmouk Basin since 1970, including forecasts:

Figure 5 – Groundwater level Yarmouk Basin 1970-2030



Source: Goode, Senior, Subah, Jaber, Ayman: Groundwater-level trends and forecasts, and salinity trends, in the Azraq, Dead Sea, Hammad, Jordan Side Valleys, Yarmouk, and Zarqa groundwater basins, Jordan, 2013

Even in the newly formulated development cooperation program "Management of Water Resources in Jordan" in 2021, the unchecked overexploitation of water resources is highlighted due to the lack of sustainable and efficient management (water distribution, water losses). This observation was already valid at the time of the project appraisal of the current hydrological monitoring network project (appraisal in 2012). Therefore, over the past ten years, it cannot be determined that the interests of all stakeholders in the planning and management of water resources have been balanced. On average, the population has access to very low levels of water per capita. Poorer population groups must manage with less water per capita and in terms of supply continuity.

Thus, the data provided by the hydrological monitoring stations' database has not or only partially contributed to improved planning and management of water resources at the macro level. However, it is not clear whether this causal relationship can be established, as the absence of such hydrological data might have led to the same or an even more severe situation.

14. Contribution to overarching (intended) developmental changes

During the project appraisal, the intended overarching development policy change (impact) was defined as "contribution to the efficient and sustainable management of Jordan's scarce water resources." From the perspective of the ex-post evaluation, the goal of "reducing the vulnerability of the Jordanian population to the impacts of climate change" is also situated at the impact level (see chapter on effectiveness). No indicators were defined for these goal dimensions. It was assumed that achieving the outcome goals (permanent availability of relevant and reliable hydrological and meteorological information) would automatically contribute to improved water resource management. This close connection is also shared from the evaluation perspective, provided that data availability leads to systematic and targeted use of these data, meaning the integration of information into decision-making processes in Jordanian resource management. This seems to be the case at the time of evaluation, with limitations regarding the actually available data.

In this sense, discussions with participants from MWI, JVA, and WAJ revealed that stakeholders use the WIS for planning and decision-making. The data from the MWI control room are an important, but not the only, data source. Other sources include the respective measuring stations of all stakeholders, which are sometimes operated in parallel at the same locations, with mostly manually measured data series from various past periods. Due to unreliable data quality, other sources are indispensable to create a comprehensive picture for meaningful investment planning.

Despite the fundamentally given causal relationship, the data provided by the hydrological monitoring stations' database has not or only partially contributed to improved planning and management of water resources at the macro level (see paragraph 13).

The extent to which the measures lead to reduced vulnerability of the population to climate-related risks depends on whether the strengthened data basis for resource management also results in corresponding investments in water supply. Only improved, stable supply performance ultimately leads to reduced vulnerability. However, from the evaluation perspective, it is not realistic to assess the actual impacts of the project measures at this level. It cannot be determined how investment decisions in the water sector were influenced by the improved data basis. Only the general causal relationship can be confirmed, provided the data basis was indeed significantly improved.

15. Contribution to overarching (unintended) developmental changes

A contribution to overarching (unintended) development policy changes cannot be determined.

Rating summary

The majority of the project efforts were focused on feeding data into a central database, which can be considered a partial success (see section on effectiveness). However, it is not measurable to what extent such data contributed to increasing the resilience of the population to the impacts of climate change. Nevertheless, data from the MWI database are part of the WIS and are used for planning and decision-making processes, such as investment planning. Significant quality compromises must sometimes be made regarding data quality, necessitating the integration of additional data from other sources and potentially further measurements.

In this respect, there is a positive correlation between the project and improved management of Jordan's water resources, and subsequently, improved supply to the Jordanian population and ultimately enhanced resilience. However, the improved resource management—and thus all subsequent objectives—are based on limited data quality.

Overarching developmental impact: moderately successful (3)

Sustainability

16. Capacities of the beneficiaries and stakeholders

The capacities identified during the project appraisal within the MWI as the basis for the logistical and organizational implementation of the project, including consulting, construction supervision, and construction services, were accurately described and assessed. The Technical Directorate of the MWI, with approximately 140 employees, served as the anchor for project implementation. Both the Water Resources Monitoring subunit (45 employees) within the Planning and Water Resources Department as part of the Technical Directorate and the Information Systems Department, which was responsible for data processing and reporting (internally within the ministry and to external requesters), were the core participants in the project's implementation within the MWI.

During the execution of its tasks, the implementation consultant was able to involve various departments and sub-departments of the MWI in providing planning services and supporting procurement and construction measures, including supervision. The greatest challenge in the last two years of the implementation period was adequately training staff for core tasks to ensure that the installed measuring stations were regularly and properly maintained by MWI personnel after the project's conclusion. While at the time of the project appraisal, only one employee carried out maintenance work and another facilitated raw data transfers to the WIS, by the project's end, three employees (two permanently) were responsible for field maintenance work, and up to three employees were responsible for data quality control. The provision of data from the MWI database to the WIS was done directly (at the time of the project appraisal, it was still done manually by an employee).

17. Contribution to supporting sustainable capacities

As part of the project, both theoretical and practical training sessions were conducted for MWI personnel. The latter were also carried out during the defect liability period for equipment installed by contractors at measuring stations. These sessions included routines ranging from problem identification to guidance and implementation of simpler calibration and maintenance tasks. Such practice-oriented training experiences contributed to the development of a maintenance protocol within the Water Resources Monitoring subunit's maintenance unit.

Results from the ex-post evaluation mission indicate that some stations exhibited operational issues, partly due to the effects of harsh climatic conditions (significantly lowered groundwater levels and droughts at some dams) and partly due to irregular on-site inspections for maintenance. The irregularity was attributed to insufficient funding for drivers, fuel, and per diems for field inspections. The calibration and maintenance work carried out by two MWI employees at the visited stations demonstrated expertise and suggested that minor errors could be quickly and properly rectified. However, when major issues requiring construction work (e.g., sensors at groundwater measurement wells) are identified, additional MWI personnel must be mobilized. When tenders are necessary to commission the work, months often pass, explaining the relatively high number of station outages in the overall network due to significant delays in such maintenance activities.

18. Durability of impacts over time

The lasting positive impact of the project depends on the measuring stations reliably collecting and transmitting raw data. The actual measurement relies on the maintenance of the station, while data transmission depends on additional tools (batteries, SIM cards). The data compilation in a database, organized by criteria, is successful and functions well. The installed hardware and software in the data room work effectively and are well integrated into the MWI's IT department.

An estimate of the required budget for sustainable maintenance of the measuring stations shows that, concerning the nationwide network of telemetry-equipped stations, each station can be visited at least once every three months for calibration and maintenance work. The associated annual operating costs, estimated at approximately 250,000 USD, include depreciation costs for procuring a new vehicle (every 4 years), expenses for fuel and maintenance, replacement of tools, spare parts, and operational and auxiliary materials for stations (batteries, SIM cards, etc.), and account for accommodation and other costs for 2 MWI employees. Therefore, the budget item of half a million dinars/year (approximately 700,000 USD) postulated in the project appraisal is high and would even allow for more extensive maintenance work. Regardless, necessary drilling and installation work for sensors at groundwater measurement wells are required.

Since a considerable number of new measuring stations were added to the original network during the project, the maintenance effort has increased by the project's end and should be more focused on by the MWI. Compared to the time of the project appraisal, more qualified personnel are currently available for maintenance work, suggesting that simpler tasks can be handled without issues if the maintenance unit is adequately funded. Larger maintenance tasks pose an operational risk due to potentially high expenses and lengthy bureaucratic processes, which can lead to station outages.

Rating summary

The project has trained MWI personnel in theory and practice to systematically implement routine maintenance processes at measuring stations. The installed hardware and software in the data room function well and are integrated into the MWI's IT department, which has sufficiently trained personnel for further support. Some measuring stations exhibit maintenance deficiencies, making data transmission impossible or faulty. Major deficiencies require extensive maintenance work, which, due to bureaucracy, may only be implemented after months, interrupting data collection and transmission at such stations. The current operational state of the stations presents a mixed picture, including completely failed stations, affecting overall sustainability.

Sustainability: moderately successful (3)

Overall rating: moderately successful (3)

The project demonstrates high relevance and coherence. However, there are significant limitations in terms of effectiveness, efficiency, impact, and sustainability. Overall, the project is still considered moderately successful.

Contributions to the 2030 Agenda

The Jordanian Water Strategy (2016-2025) aligns its goals with the SDGs and focuses on the nexus of water, energy, and food security. The overarching Jordanian goal is "Sustainable management of water and sanitation for all Jordanians." In this context, the project is embedded within the Jordanian strategy and the development policy goals of the Jordanian-German development cooperation. The project's contribution is aligned with SDG 6, aiming to ensure the availability and sustainable management of water and sanitation for all. Specifically, it targets SDG 6.1 (universal and equitable access to safe and affordable water for all) and SDG 6.4 (increasing water-use efficiency across all sectors, ensuring sustainable withdrawal and supply of freshwater to address water scarcity and significantly reduce the number of people suffering from water scarcity).

The project was designed to build on existing structures, introducing new systems while maintaining available capacities within the ministry. Implementation was led by the project sponsor MWI, in coordination with other donors, and the project results contributed to strengthening the MWI's database of measurement data as part of the WIS.

Project specific strengths/weaknesses and general conclusions/lessons learned

The strengths and weaknesses of the project include in particular:

- A valuable, nationwide comprehensive status description of the most relevant hydrological measuring stations for measurements.
- Strengthening and expanding the institutional role of the MWI as a central actor in water policy.
- During the project appraisal, there were significant uncertainties regarding the potentially achievable target levels, leading to an overly ambitious definition of the indicator levels.
- A regularly convening steering committee of the most relevant institutional stakeholders could not be established. This resulted in decisions during the implementation period regarding the location and equipment of measuring stations that did not always appear consistent.
- Despite substantial expenditures (consulting services, project funds), a considerable portion of the measuring stations functions only partially.

Conclusions and lessons learned:

- Instead of a comprehensive network of measuring stations, focusing on a smaller number of sufficiently representative locations may be advantageous. The reduced maintenance intensity could potentially be compensated by improved data quality despite the lower volume of raw data.

- Through an additional institutional component of the consulting services, the project-specific capabilities of the project sponsor (e.g., data quality assurance as a basis for information and planning) can be enhanced, thereby supporting the sustainable impact of the project measures.

- When planning measuring stations or similarly exposed/remote infrastructure, the risk of vandalism should be considered in site selection and construction execution.

- If there are significant uncertainties regarding the appropriate indicator levels during project conception (especially with innovative project approaches), tentative values can be set, which can be reviewed during the course of implementation.

Evaluation approach and methods

Methodology of the ex-post evaluation

The ex-post evaluation follows the methodology of a rapid appraisal, i.e. a data-supported, qualitative contribution analysis and represents an expert judgement. This involves attributing impacts to the project through plausibility considerations based on the careful analysis of documents, data, facts and impressions. Where possible, this also includes the use of digital data sources and modern techniques (e.g. satellite data, online surveys, geocoding). Causes of any contradictory information are investigated, attempts are made to eliminate them and the assessment is based on statements that are - if possible - confirmed by several sources of information (triangulation).

Documents:
Internal Project Documents • Program Proposal, Part A, Water Program in Jordan (08.07.2009) • Program Proposal, Part B, Financial Cooperation Module, Climate Adaptation: Hydrological Monitoring Network (09.07.2012) • Financing Agreement (06.11.2012) and Special Agreements (06.11.2012) • Final Control Report (04.03.2020) • Joint Reporting on the Development Cooperation Program Management of Water Resources in Jordan (09.01.2020) • Final Report Hydrological System Support Project by the Implementation Consultant Dornier Consulting International GmbH (July 2019)

Secondary Literature / Expert Commentaries • Commentary by BGR (07.06.2022) on the draft report "Conceptual Design Report" by the Implementation Consultant for the design of the measuring station network • Commentary by BGR (03.02.2015) on the draft report of the detailed planning by the Implementation Consultant • Integrated Water Resources Management in the Lower Jordan Valley: SMART – Sustainable Management of Available Water Resources with Innovative Technologies: Research Project on IWRM in the Middle East: Prof. Dr. Nico Goldscheider, Prof. emer. Dr. Heinz Hötzl, Dr. Jochen Klinger, Karlsruhe Institute of Technology (KIT), Institute of Applied Geosciences

Strategy Papers • National Water Strategy 2016-2025 (MWI)

Context, Country, & Sector Analyses • 40 Years of German-Jordanian Technical Cooperation in the Water Sector, GIZ (November 2018) • Rapid Assessment of the Consequences of Declining Resources Availability and Exploitability for the Existing Water Supply Infrastructure, MWI, WAJ, JVA, GIZ (2020) • Jordan Water Sector Facts and Figures, Ministry of Water and Irrigation (2020) • Jordan Country Climate Development Report, World Bank (2022)g. internal project documents, secondary specialised literature, strategy papers, context, country and sector analyses, impact evaluations, comparable evaluations, systematic reviews, media reports.

Data sources, analysis tools, interview partners:
On-site data collection, data from the sponsor's database (MWI), inspection of the locations and functionality of selected measuring stations, plausibility check of costs for interview partners: project sponsor MWI, representatives of the target group, employees of WAJ and JVA, representatives of other donors (GIZ, BGR), employees of the implementation consultant.

The analysis of impacts is based on assumed interdependencies, documented in the impact matrix developed during the project appraisal and, if necessary, updated during the ex-post evaluation. The evaluation report presents arguments as to why which influencing factors were identified for the identified results and why the analysed project presumably made which contribution (contribution analysis). The context of the development project is taken into account with regard to its influence on the results. The conclusions are set in relation to the availability and quality of the data basis. An evaluation design is the reference framework for the evaluation.

For project evaluations, the method offers a - on average - balanced cost-benefit ratio, in which the knowledge gained and the evaluation effort are in equilibrium, and allows a systematic assessment of the effectiveness of FC projects across all project evaluations. The individual ex-post evaluation can therefore not fulfil the requirements of a scientific assessment in the sense of a clear causal analysis.

Aspects limitating the evaluation:

- n.a.

Methodology of the performance evaluation

A six-point scale is used to assess the programme according to the OECD DAC criteria. The scale values are assigned as follows:

Level 1 Very successful: result significantly above expectations

Level 2 Successful: result fully in line with expectations, without significant deficiencies

Level 3 Moderately successful: below expectations, but positive results dominate

Level 4 Moderately unsuccessful: is significantly below expectations and negative results dominate despite recognisable positive results

Level 5 Unsuccessful: despite some positive partial results, the negative results clearly dominate

Level 6 Highly unsuccessful: the project is useless, or the situation has worsened

The overall rating on the six-point scale is based on a project-specific weighting of the six individual criteria. Levels 1-3 of the overall rating indicate a "successful" project, while levels 4-6 indicate an "unsuccessful" project. It should be noted that a project can generally only be considered developmentally "successful" if the achievement of the project objective ("effectiveness") and the impact on the overall objective ("overarching developmental impact") as well as the sustainability are rated as at least "Moderately successful" (rating 3).

The annex to this report is available upon request (German only).

Imprint

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