Climate risk analysis and prioritisation of adaptation measures for the Amu Darya river basin, Uzbekistan. Final Report.

Preparing the Climate Adaptive Water Resources Management in the Aral Sea Basin Project

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TA-9782 UZB

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List of Acronyms

Acronyms	Definition
ADAF	Amu Darya Adaptation Facility
ADB	Asian Development Bank
CAWRMP	Climate Adaptive Water Resources Management in the Aral Sea Basin Project
CI	Climate Indices
CIFIPWM	Center for the Implementation of Foreign Investment Projects for Water Management
CMIP	Coupled Model Intercomparison Project
DAD	District Agricultural Department
DID	District Irrigation Department
FAO	Food Agriculture Organization
GHG	Greenhouse Gases
ICG	Info Capital Group LLC
ICWC	Interstate Commission for Water Coordination of Central Asia
MCDA	Multi-Criteria Decision Analysis
MWR	Ministry of Water Resources
NDC	Nationally Determined Contributions
PPP	Public-Private Partnership
SIC	Scientific Information Center
SPEI	Standardised Precipitation Evapotranspiration Index
SSP	Shared Socioeconomic Pathways
TA	Technical Assistance
VITO	An independent Flemish research organisation in the area of cleantech
WB	World Bank
WEAP	Water Evaluation And Planning
WRI	World Resources Institute
WSDI	Warm spell duration

I. Introduction

I.1. Context

Uzbekistan's water resources depend mainly on the Amu Darya River. The water resources of this transboundary river are practically fully allocated to different uses across the basin. This implies that Uzbekistan is highly sensitive to changes in upstream and in-country water availability. In particular, the country will be impacted by climate change, which will alter glaciers and snow cover, water availability, water uses and demands across the river basin. These changes in intra-annual and seasonal variability are therefore a threat to Uzbekistan's water security.

Besides, climate change will increase extreme events, which pose a risk to existing water resources infrastructures. If no action is taken, water users and uses, including the environment and the Aral Sea, will face the consequences in the next few decades. This is particularly the case for the agricultural sector, which will need to transform to more resilient systems at all levels.

As a response, the technical assistance *TA-9782 UZB: Preparing the Climate Adaptive Water Resources Management in the Aral Sea Basin*, approved in August 2019, supports the government in enhancing the river basin planning in the Amu Darya River basin. In addition to preparing investments in representative irrigation and drainage areas, it undertakes a long-term and knowledge-based approach to deliver climate adaptive solutions for water resources management.

In the context of this TA, the Assignment, object of this final report, was commissioned to assess climate change risks in the Amu Darya river basin and identify climate-resilient investment measures in a participatory manner.

I.2. Objectives and Approach of the Assignment

This Assignment supported the Ministry of Water Resources (MWR) in assessing climate change risks in the part of the Amu Darya River basin located in Uzbekistan. Focusing on three particular districts, Type 2 adaptation measures were identified through consultations and prioritisation. An explicit focus of the investments is to reduce vulnerability to climate change; therefore, measures (hard and soft) strengthening adaptation capacity were prioritised.

The Assignment had three main tasks, as detailed below and represented in Figure 1.

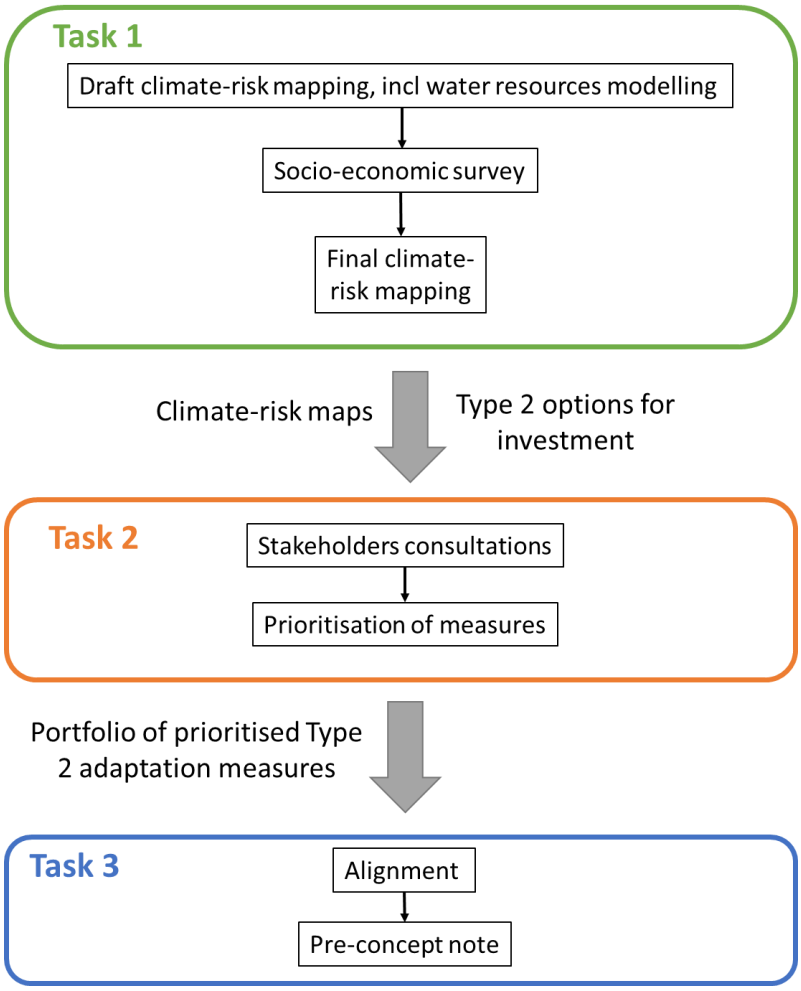

Figure 1: Schematic of the approach

Task 1 was a basin-wide climate change risk and adaptation analysis. It required the following activities:

- Climate risks mapping in the Amu Darya river basin, focusing on water resources management, irrigation and agriculture production.
- Employ a water resources system model to identify dependencies across the basin.
- Conduct a socio-economic survey in the basin, focusing on the three districts of Kitab, Konlikul and Gurlan.

Task 2 was about strategic climate change adaptation planning in the three districts of Kitab, Konlikul and Gurlan. It identified potential soft and hard measures in the three districts, engaged and consulted with stakeholders to refine further the measures and prioritise them using a multi-criteria analysis. The integrated climate adaptation-focused approach should ensure that a so-called Type 2 project can be delivered, and any hard measures (infrastructures) proposed can be classified as 'Type 2' adaptation investment[1].

Lastly, Task 3 identified priority measures and portfolios for the three districts of Kitab, Konlikul and Gurlan. It aimed to:

- Align with existing and ongoing national and sectoral processes, strategies and plans.

[1] Type 2 adaptation projects are designed around climate adaptation, i.e., where addressing climate risks is the primary objective, while the more common Type 1 adaptation activities focus on climate proofing of more typical proposed development investments. Watkiss et al (2020) Principles of Climate Risk Management for Climate Proofing Projects, ADB Sustainable Development Working Paper No. 69 July 2020

- Prepare a pre-concept note for the prioritised adaptation investment.

The Assignment was conducted by a team of consultants consisting of two individual international consultants, a climate change specialist and a climate change economist, and two Uzbek consulting firms, Info Capital Group (ICG) and Index Consulting.

I.3. Content of the report

The final report summarises the activities carried out during the Assignment. It is organised into three chapters along the three main tasks. Outputs of these activities are reported in separate reports listed in Annex 1.

II. Task 1: Basin-wide climate change risk and adaptation analysis for the Amu Darya River basin

Task 1 is reported below as per the following activities:

- Method and data used for climate risk mapping.
- Water resources modelling to include upstream and downstream dependencies in climate risk maps.
- Climate risks mapping in the Amu Darya river basin, focusing on water resources management, irrigation and agriculture production.
- Socio-economic survey in the basin, focusing on the three districts of Kitab, Konlikul and Gurlan.

II.1. Method and data for climate risk mapping

II.1.a. Method

Climate risk maps were produced for the Amu Darya River basin, focusing on water resources management, irrigation, agriculture production and environmental assets. The maps had to identify hotspots of water resources-related challenges, areas, infrastructure, and activities in the Amu Darya basin at high risk due to climate change and water-related hazards. This includes natural hazards driven or strongly affected by hydrological and climatic conditions.

Risk was calculated as a function of the hazard occurrence and vulnerability. Figure 2 shows this conceptually, in which:

- Hazard (H) refers to the climate-related process that causes the impacts, loss of performance, social and economic disruption, and environmental degradation (such as droughts, floods, or dust storms).
- Exposure (E) refers to the people and physical assets (e.g., infrastructure, housing, crops, land, ecosystems, forests) enduring the hazard (e.g., irrigation districts, canals, cities).
- Vulnerability (V) refers to the degree of sensitivity to suffering impacts from a hazard and the degree of adaptive capacity to cope with the hazard (e.g., areas with high irrigation requirement have a higher sensitivity to water scarcity).

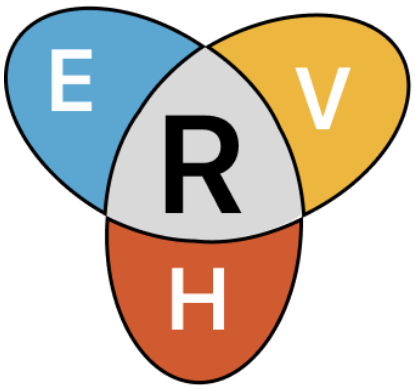

Figure 2: Risk (R) is defined as a function of Hazard (H), Exposure (E), and Vulnerability (V) components: R=f(H,E,V)

The impact of climate change is represented in the change in hazards in the future. For each climate-related hazard, one or more Climate Indices (CI) can be associated (see Figure 3), representing the climate drivers affecting the historical period's baseline hazard rating. CI are used as a proxy to estimate the change in hazard compared to the baseline. The historical baseline values for the CI are defined as the normal over the 20-year period 1995 to 2014. Changes in the CI under climate change were computed for the long-term time horizon (years 2080-2100) under the (pessimistic) SSP5 (Shared Socioeconomic Pathways) pathway. This approach potentially exacerbates water resource-related challenges but ensures that climate risks are better discerned and identified. More details can be found in the standalone report "Climate Change Risk Mapping of the Amu Darya river basin, Uzbekistan" produced during the Assignment (see Annexe 1). Eventually, the future hazards for the long-term time horizon (years 2080-2100), under the family of climate change scenarios SSP5, are considered for computing the climate-related risks.

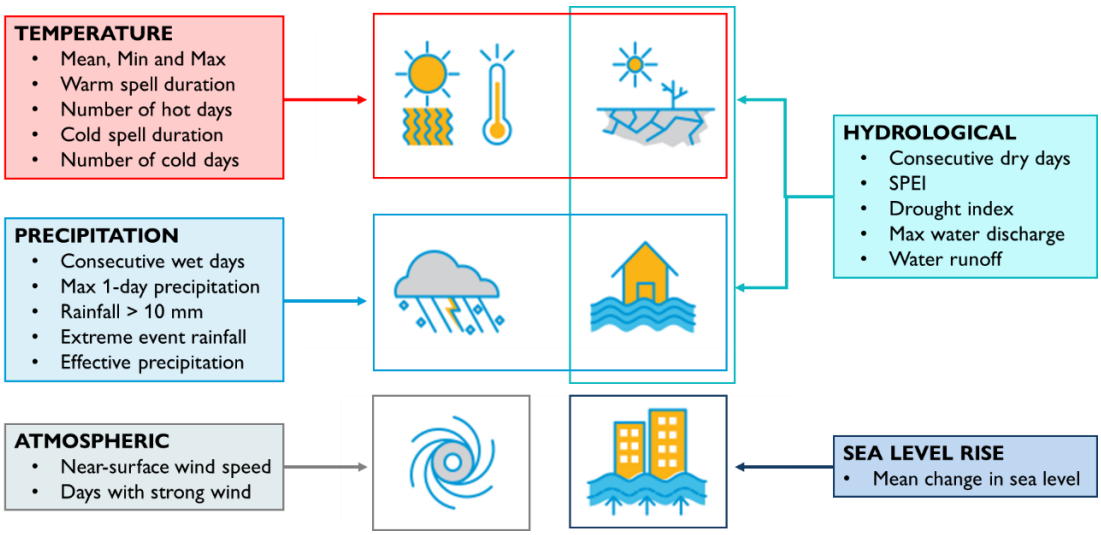

Figure 3: Climate Indices (CI) related to climate hazards (source: Amadio et al., 2022[2])

Exposure to climate and geophysical hazards focused on the key water resources-dependent sectors, which are (a) agriculture, (b) water supply infrastructure, and (c) vital ecosystems and their services (e.g., south Aral Sea, Aral Sea delta, rivers, wetlands). Critical infrastructure and facilities were identified based on the United Nations Office for Disaster Risk Reduction, which lists primary physical structures, technical facilities, and systems that are socially, economically, or operationally essential to the functioning of a society or community.

Another methodological element was considering hazards and vulnerabilities specific to Eco-hydrological zones. A state-of-the-art global dataset, which combines several scientific criteria to classify the globe into different zones, was used (Dinerstein et al., 2017)[3]. Each ecoregion represents a distinct assemblage of biodiversity (all taxa, not just vegetation) whose boundaries include the space required to sustain ecological processes. Applied to the Amu Darya basin, five distinct eco-hydrological Zones are defined: Aral Sea, Lower, Mid, Riverine, and Upper (Figure 4). Specific hazards and vulnerabilities were identified for each ecozone.

[2] Amadio, M., Hunink, J.E. Fourniadis, Y., 2022. ADB Climate and Disaster Risk Screening and Assessment Tool – Methodology. TA-9414, ADB

[3] Eric Dinerstein, David Olson, Anup Joshi, Carly Vynne, Neil D. Burgess, Erik Wikramanayake, Nathan Hahn, Suzanne Palminteri, Prashant Hedao, & Reed Noss. (2017). An Ecoregion-Based Approach to Protecting Half the Terrestrial Realm. BioScience, 67(6), 534–545. https://academic.oup.com/bioscience/article-abstract/67/6/534/3102935

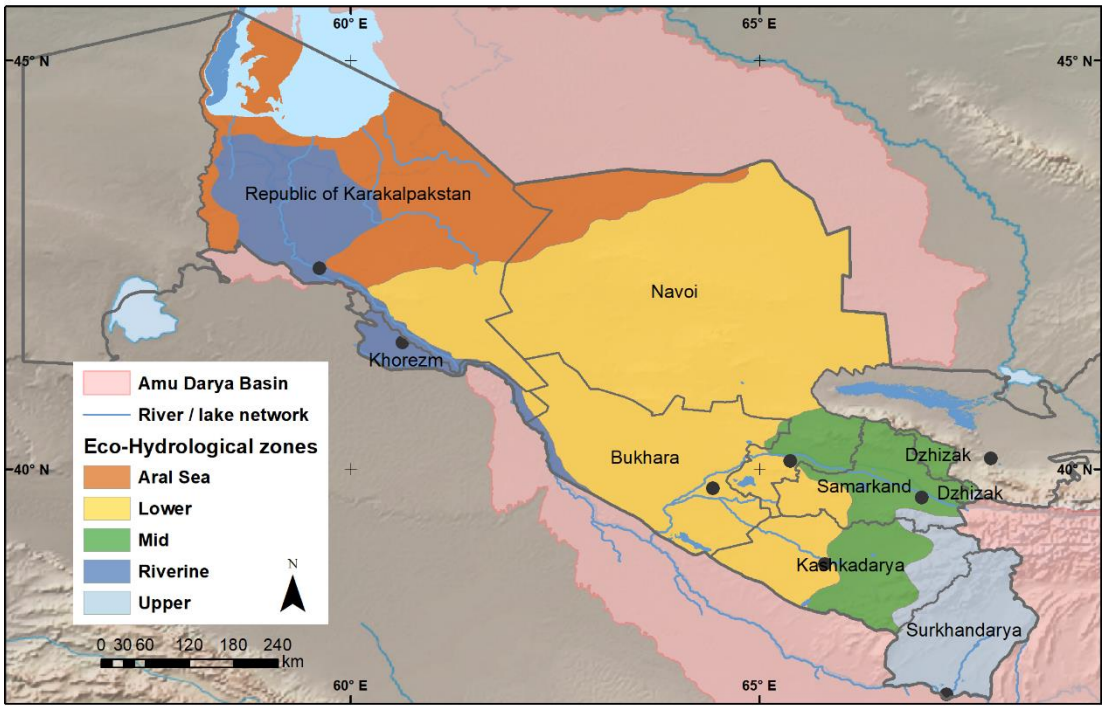

Figure 4. Amu Darya basin, divided into five ecozones, based on RESOLVE Ecoregions 2017.

II.1.b. Data

The data for the risk mapping came from different datasets, as summarised in Table 1 to Table 3. The table lists the most relevant hazards, exposures and vulnerabilities in the Amu Darya basin.

Table 1: Most relevant hazards identified for the Amu Darya basin and data sources.

Hazard	Baseline dataset	Baseline metric	Associated Climate Index
Drought	FAO Agricultural Stress Index[4]	Frequency of drought affecting >30% land	Standardised Precipitation Evapotranspiration Index (SPEI)
Rainfall-induced landslides	WB Global Landslide[5]	Average annual frequency of significant rainfall-triggered landslides per sq. km for 1980-2018	Annual maximum 5-day consecutive precipitation (Rx5day)
Rainfall-induced erosion	GloREDa Rainfall erosivity factor[6]	Rainfall erosivity above a certain threshold	Annual maximum 1-day precipitation (Rx1day)
Heat waves	VITO Global Heat Model[7]	20-years mean return value of temperature above a certain threshold	Warm spell duration (WSDI)
River floods	WRI Global Flood Model[8]	Water depth return period 100 year	not applicable

[4] https://data.apps.fao.org/catalog/organization/about/asis
[5] https://www.geonode-gfdrrlab.org/layers/rftl_aa_mean_1980_2018:hazard:rftl_aa_mean_1980_2018
[6] https://esdac.jrc.ec.europa.eu/content/global-rainfall-erosivity
[7] https://www.geonode-gfdrrlab.org/layers/hazard:intensity_returnperiod20y
[8] www.wri.org/applications/aqueduct/floods

Hazard	Baseline dataset	Baseline metric	Associated Climate Index
Glacial Lake Outburst Floods	Remote sensing-based dataset[9]	Proximity indicator	Annual maximum 5-day consecutive precipitation (Rx5day)
Dust storms and wind erosion	Wind erosion risk potential[10]	Severity indicator	CMIP6 Wind speed projections
Wildfire	Fire Weather Index[11]	30-year return period intensity value	Warm spell duration (WSDI)

Table 2: Exposure datasets associated with hazards

Hazard	Exposure dataset	Metric
Drought, Dust and windstorms, Rainfall-induced landslides, Rainfall-induced erosion, Heat waves, Wildfire, River floods, Glacial Lake Outburst Floods	– WUEMoCA dataset – Gridded Population of World Version 4[12]	– Net Irrigated Area (in ha) – Nr. inhabitants per km^2

Table 3: Vulnerability datasets associated with hazards

Hazard	Vulnerability dataset	Metric
Drought, dust, and windstorms	WRI Aqueduct Water Risk[13]	Water Demand, measured as water withdrawals. Projected change in water withdrawals is equal to the summarised withdrawals for the target year, divided by the baseline year, 2010.
Rainfall-induced landslides	WUEMoCA dataset[14]	Inverse of Water Productivity (1/$ m^{-3}) for cotton, rice, wheat
Rainfall-induced erosion	WUEMoCA dataset	Inverse of Water Productivity (1/$ m^{-3}) for cotton, rice, wheat
Heat waves, Wildfire	WRI Aqueduct Water Risk	Water Stress, measured as the ratio of demand for water by human society divided by available water.
River floods, Glacial Lake Outburst Floods	WUEMoCA dataset	Net Irrigated Area (in ha)

II.2. Climate risk mapping

Climate risk maps were prepared for the following five key hazards in the basin:

- drought,
- rainfall-induced landslide,
- rainfall-induced erosion,
- heat waves,
- fluvial floods.

They were elaborated for the long-term time horizon (years 2080-2100), under the family of climate change scenarios SSP5.

[9] Petrov, Maxim A., Timur Y. Sabitov, Irina G. Tomashevskaya, Gleb E. Glazirin, Sergey S. Chernomorets, Elena A. Savernyuk, Olga V. Tutubalina et al. "Glacial lake inventory and lake outburst potential in Uzbekistan." Science of the Total Environment 592 (2017): 228-242.

[10] Prepared by FutureWater using data sets available in Google Earth Engine

[11] https://www.geonode-gfdrrlab.org/layers/hazard:csiro_wf_max_fwi_rp30

[12] https://sedac.ciesin.columbia.edu/data/collection/gpw-v4

[13] https://www.wri.org/aqueduct

[14] https://wuemoca.geo.uni-halle.de/app/

Detailed results can be found in the report "Climate Change Risk Mapping of the Amu Darya river basin, Uzbekistan" produced during the Assignment. A summary of the risk maps that were made is shown in Figure 5.

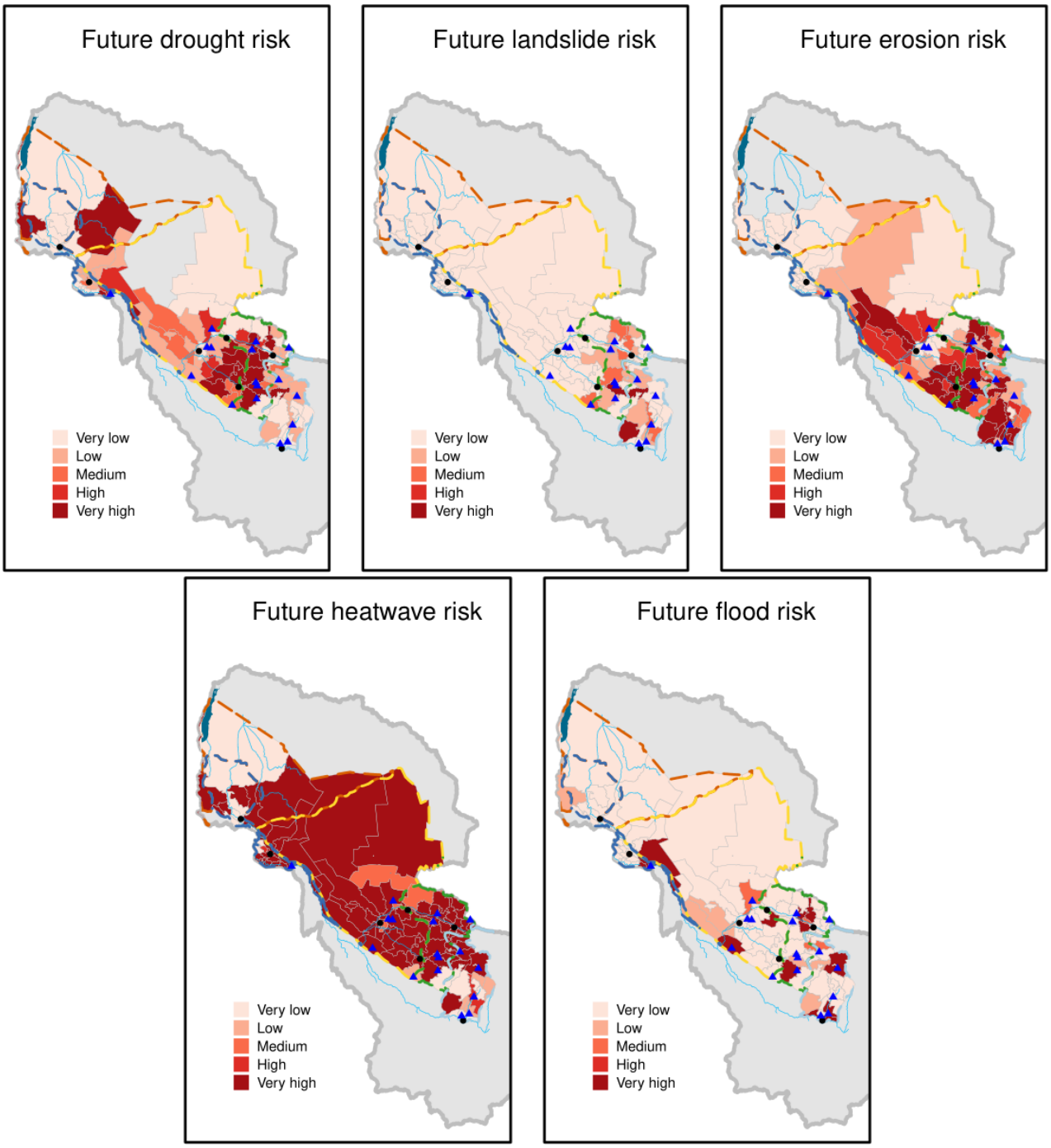

Figure 5: Maps for the five key risks for the long-term (years 2080-2100), under the family of climate change scenarios SSP5.

II.3. Water resources system model to identify dependencies across the basin

A river basin perspective is needed to identify adaptation options that bring optimal resilience benefits. Such an approach makes sure to prioritise options benefiting downstream water resources, while bringing more resilience to upstream areas. Water-related hazards and related adaptation measures in the upstream tributaries of the Amu Darya (e.g., droughts or erosion) can have notable positive or negative impacts on downstream areas. To assess these impacts, a water resources system model is a suitable tool to be used.

Such a model simulates the water supply and demand of the different areas, considering the infrastructures and allocation rules in place, all in one integrated analytical tool at the river basin level.

An existing water resources system model for the Aral Sea basin was used and adapted for this study. The model was developed with the Water Evaluation And Planning (WEAP[15]) software. It was slightly adapted for this study (Figure 5). This modelling exercise aimed to support the case for an integrated approach in selecting adaptation interventions across the river basin by exploring a few illustrative scenarios. The model was not used for assessing the impact of the adaptation portfolios – this would require more elaborate modelling work, incorporating updated water resources data unavailable for this work.

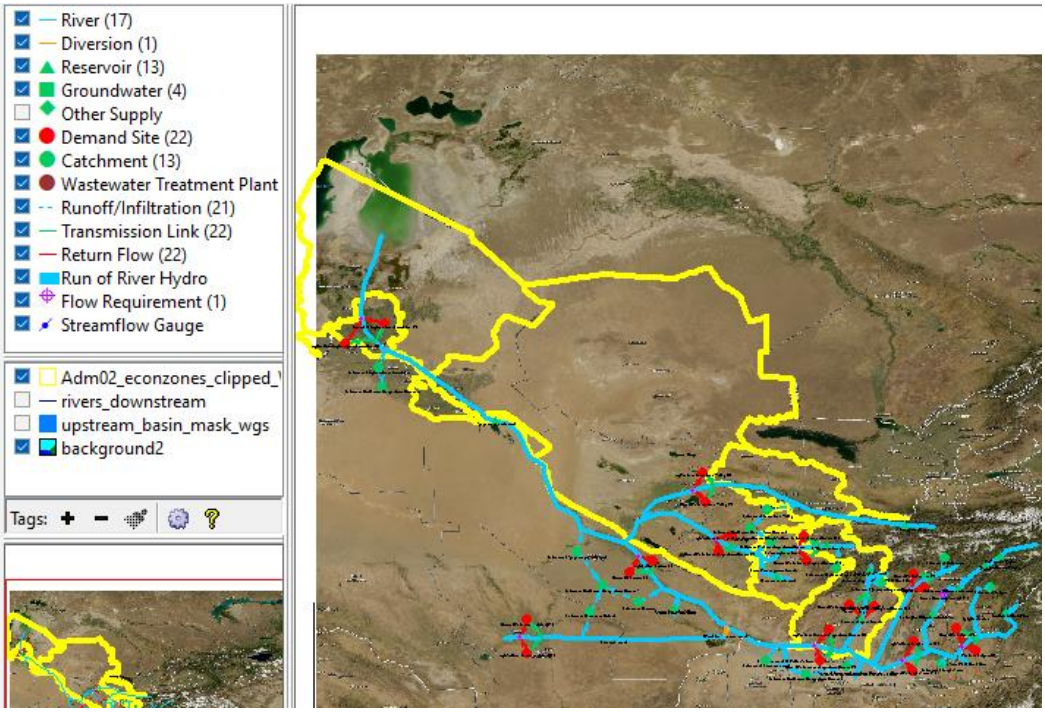

Figure 6. Screenshot of the WEAP-Aral model (Source: Hunink et al, 2014[16])

Four scenarios were considered: a reference (=business-as-usual) and three exploratory adaptation scenarios, as summarised in Table 4 through related hazards and adaptation measures. The modelling focused on the downstream impact of upstream adaptation measures, the latter being a mix of infrastructure investments and softer measures (e.g., sustainable catchment management options, nature-based solutions, management options).

Table 4. Summary table of the exploratory adaptation scenarios

Scenario name	Related hazards	Examples of typical adaptation measures	Scenario implementation
Reference	All	Business as usual (no adaptation)	-
Drought Mitigation	Drought	Improved agricultural practices, improved cropping cycles and patterns, improved water allocation mechanisms, etc	Reduced demands downstream by 10%

[15] http://weap21.org/

[16] Hunink, J.E., A.F. Lutz, P. Droogers. 2014. Regional Risk Assessment for Water Availability and Water-related Energy Sector Impacts in Central Asia. FutureWater Report 196. Download link

Scenario name	Related hazards	Examples of typical adaptation measures	Scenario implementation
Sedimentation Mitigation	Erosion and landslides	Catchment interventions reducing erosion, improved agricultural practices reducing erosion, measures reducing mudflow hazard, etc	Reservoir capacity loss due to sedimentation was reduced by 50%
Flood Mitigation	Flood	Buffer for flood mitigation in reservoirs, nature-based solutions upstream of reservoir, etc	20% of the storage capacity is reserved for buffering floods

The scenarios focused on the Kashkadarya tributary and its Gissarak and Chimkurgan reservoirs (Figure 7).

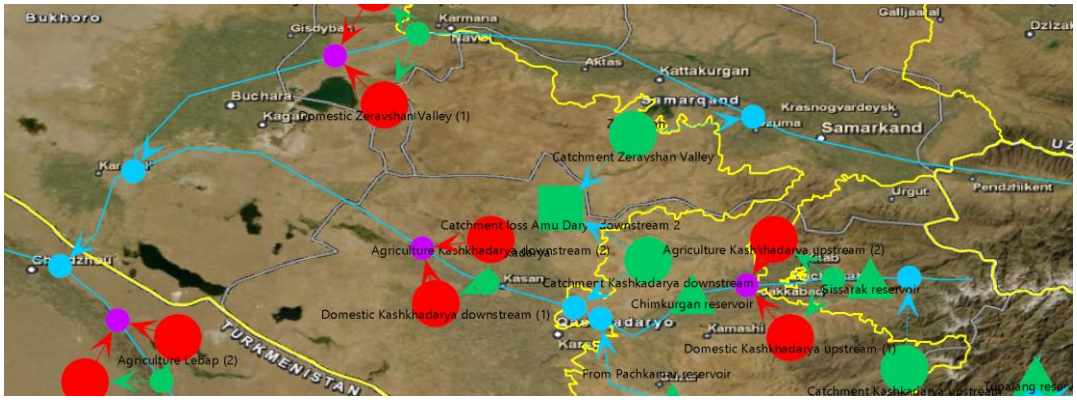

Figure 7. Zoom of the schematic of the Kashakdarya tributary in the WEAP-Aral model.

Results were shown for mitigating drought, sedimentation and flood. More details can be found in the report "Climate Change Risk Mapping of the Amu Darya river basin, Uzbekistan" produced during the Assignment.

II.4. Socio-economic survey

The objective of the socio-economic survey was to characterise the vulnerability of rural livelihoods (e.g., type of agricultural practice being vulnerable to a particular climate hazard, identifying the most important crops for livelihood and their vulnerability). The survey also served to identify the needs, existing coping mechanisms, barriers and opportunities related to climate change.

The survey was based on the earlier survey "*Socio-economic Baseline Survey For Preparation of the CAWRMP (Jondor and Bobatag subprojects)*"[17] and designed in close consultation with the Ministry of Water Resources and ADB. It was decided to survey two steps:

- A rapid online survey covering 15 districts.
- A detailed survey in three of those 15 districts.

II.4.a. Rapid online survey

A questionnaire was prepared for representatives of the District Irrigation Department (DID), District Agricultural Department (DAD), Council of Farmers, Dehkans and Household Plot Owners, and district branches of "Uzsuvtaminot" JSC. The questionnaire was to be sent and filled by recipients. It covered topics

[17] ICG (2020), *Socio-economic Baseline Survey For Preparation of Climate Adaptive Water Resources Management in the Aral Sea Basin Sector Project (Jondor and Bobatag subprojects)*. Final Report. TRTA 53120-002 UZB Preparation of Climate Adaptive Water Resources Management in the Aral Sea Basin Sector Project.

related to agriculture, irrigation, domestic water supply, impact of climate change on these uses and existing adaptation strategies. It was reviewed and approved by the Ministry of Water Resources (MWR).

In close consultation with the MWR and the ADB, 15 districts were selected for the rapid survey (Table 5). Their locations were chosen as follows:

- For each region, the two districts facing the greatest challenges for water management were selected.
- The Ministry plans to build the Ayakshi dam in Kitab district, Kashkadarya region, and therefore requested to add this district to the list.

Table 5: List of the 15 districts selected for the rapid online survey

N	Districts	Regions
1	Konlikul	Republic Karakalpakstan
2	Turtkul	
3	Gurlan	Khorezm
4	Kushkupir	
5	Alat	Bukhara
6	Bukhara	
7	Koson	Kashkadarya
8	Guzar	
9	Kitab	
10	Shurchi	Surkhandarya
11	Bandihon	
12	Karmana	Navoiy
13	Khatirchi	
14	Pastdargom	Samarkand
15	Samarkand	

About 60% of the recipients sent back filled questionnaires. Main results are as follows:

- The state of the irrigation and drainage system is generally assessed to be satisfactory (66% of the respondents). Low technical level is nevertheless reported, due to a lack of financial resources for dredging and repair operations, impacting the availability of water resources.
- Almost all the population in the 15 districts has a centralised water supply, with some cases where access is less than 10%. Groundwater is the main source of domestic water, although water from reservoirs is used when available. However, access to a centralised sewerage system is missing in all districts except the Samarkand district. According to the respondents, the main problems of water supply and sanitation include failure of water supply and distribution system (19%), lack of natural freshwater sources (17%) and lack of sewerage system (22%).
- Most respondents (59%) thought climate change has substantially affected the hydrological regime of rivers. Increased number of hot days (26%) and frequent droughts (15%) were indicated as the main climate change problems related to water resources and agriculture. Shortage of irrigation water is critical for all districts, except for Kasan district.
- Climate change is assessed to have already impacted cotton, wheat, horticulture, livestock, and poultry.
- Adaptation measures reported by the respondents were mainly drip irrigation systems (26%), selection of drought- and heat-resistant crop varieties (24%), alternative agronomic practices (e.g., soil tillage, crop rotation, intercropping) (22%) and greenhouses. There are however barriers to adopting these adaptations, such as financial (26%) and technical (24%).

More detailed results can be found in the "Report on Results of Online Survey Conducted in 15 Districts of 7 Regions in Amu Darya River Basin of the Republic of Uzbekistan" produced during the Assignment.

II.4.b. Detailed onsite survey

Among the 15 districts, a detailed survey was conducted in the following three districts: Kitab, Konlikul and Gurlan. These three districts were selected in close consultation with the MWR and the ADB. Konlikul and Gurlan were chosen as they face exceptionally high water management challenges. Kitab was included since the Ministry plans to build the Ayakshi dam in this district, and assessing its context is crucial.

The questionnaire covered the same topics as the one for the rapid online survey, although it delved into deeper details and was tailored to live onsite interviews:

- individually with representatives of the DID, DAD, Council of Farmers and district branches of "Uzsuvtaminot" JSC;
- in focus group discussions with Dehkans and Household Plot Owners, cluster farmers and women groups.

The questionnaire was piloted in Kitab district, and an updated version was used for Konlikul and Gurlan.

Results gave further precision to those from the rapid online survey. Main points are:

- In the last decades, communities moved gradually away from using surface water, due to upstream/downstream issues and scarcity, in favour of groundwater, to supply irrigation and domestic water. However, interviewees were conscious that taping groundwater is not sustainable, costing more as groundwater drops. Furthermore, there are also quality issues with using groundwater, with high mineralisation and salinity, impacting negatively the crops and forcing the purchase of commercial drinking water. Participants from Kitab expressed the wish to have the Ayakshi reservoir built to cover their needs.
- Climate change has been observed in the last decades. In addition to those mentioned during the rapid survey, impacts are mudflows, more pests and diseases, and greater damages due to early flowering and frosts.
- Interviewees mentioned using house-level water-saving equipment to avoid wasting domestic water.
- Additional alternative agricultural practices, such as hydroponics, using polyethylene film as greenhouse, mulching, agroforestry and intercropping, were mentioned.
- The government provides tax incentives to promote water-saving technologies.
- Advisory services (agronomic, climatic) exist through different channels (e.g., social media, SMS, radio) informing on the weather or training. However, some interviewees, especially small farmers out of clusters, did not benefit from these services, which should be extended to better adapt to changing situations.
- Climatic hazards, especially drought, have led to greater job migration, mostly of young men but also women in a few cases.
- Women have gradually taken up entrepreneurial activities (e.g., bakery, tailoring, kindergartens) to complement household revenues.
- Participants in Kitab district expressed high expectations for building the Ayakshi reservoir.

More detailed results can be found in the following two documents produced during the Assignment:

- Report on Field Survey Results for Kitab District Kashkadarya Region.

- In-depth Surveys Conducted in Konlikul District of the Republic of Karakalpakstan and Gurlan District of the Khorezm Region.

III. Task 2: Strategic climate change adaptation planning

Task 2 was about strategic climate change adaptation planning in the three districts Kitab, Konlikul and Gurlan, with soft and hard measures. There were also consultations with stakeholders from different sectors and levels (provincial and national) and the ADB. Fed with inputs from these consultations, a Multi-Criteria Decision Analysis (MCDA) prioritised the proposed measures in the districts. The integrated climate adaptation-focused approach ensured that so-called Type 2 adaptation measures can be delivered, and any proposed hard measures (infrastructures) can be classified as 'Type 2' adaptation investment. The main output of the second task is a portfolio of Type 2 prioritised adaptation measures.

The followed process is summarised in Figure 8 and explained in detail below.

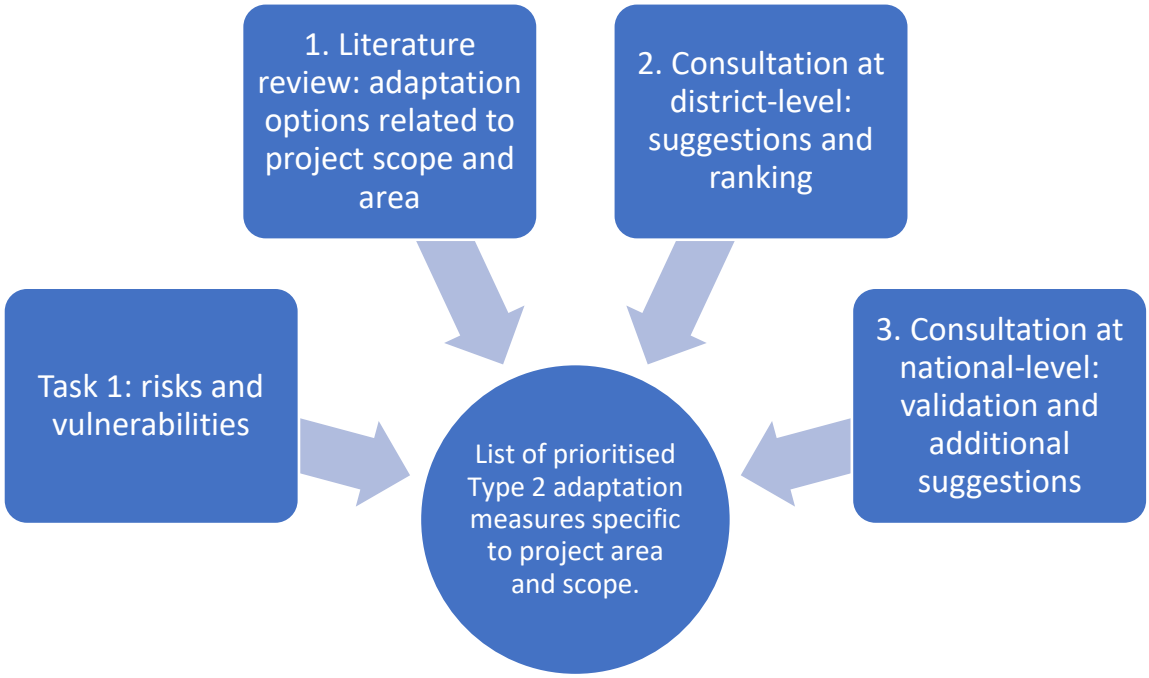

Figure 8: Approach to the identification of prioritised Type 2 adaptation measures.

III.1. Preparation of the consultations

The approach proposed initially during the inception phase was to set up official MDCA groups, with the participation of relevant stakeholders nominated by the Ministry of Water Resources. The groups would have contributed to preparing the list of potential measures to be presented during district consultations and defining the criteria and weights of the MDCA. Unfortunately, the MDCA groups were not nominated in time for the district workshops and therefore the finalisation of measures, criteria and weights was carried out during the district workshops themselves.

III.1.a. Identification of potential Type 2 adaptation measures

Lists of soft and hard Type 2 adaptation measures were identified before consultations, specifically for Kitab, Konlikul and Gurlan districts. The lists were based on Task 1, its maps and socio-economic survey, and other reports available for Uzbekistan, including Uzbekistan's Nationally Determined Contributions (NDCs).

Typical hard measures were creating and enhancing water storage capacity, reducing domestic non-revenue water, improving domestic water supply networks, better wastewater management, improving water use efficiency (irrigation and domestic water supply), adopting crops and livestocks more robust to climate extremes and salinity, greater adoption of greenhouses with drip irrigation and hydroponic and develop biogas.

Typical soft measures were community cooperatives for crops and livestock, farmer-to-farmer training on alternative practices and better agro-climatic services.

Typical measures of mixed hard and soft natures were to improve Early Warning Systems and promote domestic greywater reuse for industries and irrigation.

A first estimation of the total cost was also computed for each proposed measure.

More details on these initial measures can be found in the following three reports:

- Workshop: Adaptation Options in Amu Darya River Basin in Kitab, 12-13 April 2023.
- Workshop: Adaptation Options in Amu Darya River Basin in Gurlan, 17 August 2023.
- Workshop: Adaptation Options in Amu Darya River Basin in Kanlikul, 24 August 2023.

III.1.b. Criteria for the Multi-Criteria Decision Analysis (MCDA)

A framework to be employed during consultations, using inputs from the participants, was elaborated before the consultations. It was to be used to prioritise the proposed Type 2 adaptation measures. It has been designed to construct recommendations for investment portfolios in such a way that the added value of ADB and climate finance is clear and can be quantified.

Based on available reports, the initial list of criteria prepared before the consultations was as follows:

1. Investment costs.
2. O&M costs.
3. Poverty reduction / alleviation.
4. Revenue generation potential.
5. Climate resilience.
6. Biodiversity & ecosystems.
7. Technical feasibility.
8. Impact on women and children.
9. Water and food production & security.

Performance matrices, which qualitatively show how each potential measure performed on the criteria, were prepared for Konlikul and Gurlan districts.

III.2. Consultation at the district level: definition and prioritisation of Type 2 adaptation measures

The objectives of the consultations were to define and prioritise the Type 2 adaptation measures. A workshop was organised in each of the three districts (Kitab, Konlikul and Gurlan), in April and August 2023, to be close to the actual needs on the ground. The ADB participated in these meetings.

In summary, the process for each workshop was as follows:

1. Present the initial list of measures.
2. Discuss and amend these measures, if need be.
3. Present the list of criteria for the MDCA, and amend if need be.
4. Ask the participants to score the measures against the criteria.

5. Ask the participants to determine the weights of each criterion.

More details can be found in the following three reports:

- Workshop: Adaptation Options in Amu Darya River Basin in Kitab, 12-13 April 2023.
- Workshop: Adaptation Options in Amu Darya River Basin in Gurlan, 17 August 2023.
- Workshop: Adaptation Options in Amu Darya River Basin in Kanlikul, 24 August 2023.

III.3. Construction of draft investment portfolios

Draft adaptation portfolios were developed, to propose Type 2 investment packages covering the three districts. The successive steps were: (i) derive the list of prioritised measures in each district and (ii) assemble them in draft investment portfolios.

III.3.a. List of prioritised district measures

During the district consultations, the participants amended some of the suggested Type 2 measures and scored them against the MDCA criteria. Using their choices for the criteria weights, a weighted final score was calculated for each measure, allowing the measures to be ranked from the greatest to the smallest weighted score.

The list of Type 2 prioritised measures is shown in

Table 6. Measures also include an option where no action is taken; this “No action” measure scored the worst in Kitab and Konlikul.

Table 6: List of prioritised Type 2 measures for Kitab, Konlikul and Gurlan districts, listed from the most to the least prioritised (the lower the rank value, the higher the priority).

Rank	Measure
Kitab	
1	Implement ecosystem-based approaches to adaptation to protect, maintain, and restore degraded habitats with active community participation.
2	Improved flood protection such as construction of reservoirs, irrigation network infrastructure, construction of dikes, construction of eco-based solutions, etc.
3	Promote the use of conservation agriculture (e.g. organic, biodynamic, zero and minimum/ conservation tillage, fallow practices, etc.).
4	In order to provide (production of) value-added products, sustainable pasture management, improve fodder production and transfer small ruminants from open pastures to breeding on farms, formation of controlling public cooperatives.
5	Changing to more drought, salt and heat resistant crops and crop species on the area of … ha, as well as heat resistant animals and animal species in animal husbandry.
6	Implementation of irrigation schemes, water-saving technologies, such as drip, sprinkler and night irrigation, based on accurate research, taking into account the impact on the environment.
7	Improve Early Warning Systems.
8	Enhancing water storage capacity in natural dams and water retention systems.
9	Enhancing performance and efficiency of water utilities through technological improvements and capacity development for reducing water loss.
10	Reducing groundwater use for irrigation and enhancing water recharge technologies including managed and artificial groundwater recharge mechanisms.
11	No action
Konlikul	

Rank	Measure
1	Create a new cropping pattern system with more salt-resistant, drought-resistant and heat-resistant crops and organise pilot plots to demonstrate their results. Cropping pattern system established on 1000 ha with pilot plots of 100 ha to systematically measure the impact.
2	Construction of new and reconstruction of existing water supply and sewage systems, equipping them with special machinery and equipment (coverage of 50,000 consumers, construction and reconstruction of drinking and sewer networks and pumping stations, expansion of treatment facilities).
3	Reconstruction of irrigation network including: 71 km of inter farm canals and 500 km of intra farm canals.
4	Installation of micro-plants for groundwater desalination when drinking water is supplied (with a capacity of 24 m3 per day).
5	Creation of new livestock and poultry breeds that are salt, drought and heat resistant. 50 farms will be supplied with new breeds to regularly study the effect.
6	Construction of new sewerage stations for drainage and wastewater treatment, including new aeration stations with a capacity of 4000 m3/day and further use.
7	Measures for the conservation of existing forests and trees.
8	Strengthening the potential of water management organisations through the establishment of modern equipment and special technical equipment for irrigation and drainage networks.
9	Reconstruction of existing pumping stations and power supply networks, including substations.
10	Introduction of modern methods and technologies of soil cultivation and irrigation (deep loosening on an area of 5000 hectares, field laser leveling, the use of flexible pipes and the introduction of discrete irrigation technologies).
11	Organise farmer-to-farmer trainings (with local or foreign lecturers/consultants) on new irrigation techniques and technologies covering 15% of farmers with a total of 3 training days per farmer.
12	Establishment of cooperation between farms and clusters and Uzgidromet. (provision of meteorological and agrometeorological data, establishment of mini-meteorological stations).
13	Installation of pumps powered by solar panels for pastures irrigation.
14	No action
Gurlan	
1	Develop a system of agricultural inputs supply for farmers covering all farmers.
2	Implementation of modern techniques and technologies for soil cultivation and irrigation (on the area of 5000 ha): deep loosening, laser planning of field, use of flexible pipelines and discrete irrigation.
3	Establishment of cooperation between farms and clusters and Uzgidromet. (provision of meteorological and agrometeorological data, establishment of mini-meteorological stations).
4	Create a new cropping pattern system with more salt-resistant, drought-resistant and heat-resistant crops and organise pilot plots to demonstrate their results. Cropping pattern system established on 1000 ha with pilot plots of 100 ha to systematically measure the impact.
5	Construction of 200 hectares of greenhouses where drip irrigation, hydrogel and hydroponic techniques will be used.
6	Development of technologies for reducing the salinity of collector-drainage waters for their subsequent use in irrigation.
7	Equipping irrigation networks with modern water measuring equipment when supplying water to users.
8	Develop and rehabilitate the drainage system covering 30,350 hectares to decrease the level and mineralisation of ground water.
9	Development and installation of biogas equipment with total annual biogas production capacity of 5 million m3 to supply greenhouses with heating.
10	No action.
11	Reconstruction of irrigation network including: 144 km of inter farm canals and 380 km of intra farm canals.

Rank	Measure
12	Organise a 3-day training on the study of new methods and technologies of inter-farm interaction (with the participation of local or foreign students/consultants) with the involvement of all interested farmers.
13	Construction of new and overhaul of existing water supply and sewerage systems, and equipping with modern treatment plants.

More details on the process can be found in the following three reports:

- Workshop: Adaptation Options in Amu Darya River Basin in Kitab, 12-13 April 2023.
- Workshop: Adaptation Options in Amu Darya River Basin in Gurlan, 17 August 2023.
- Workshop: Adaptation Options in Amu Darya River Basin in Kanlikul, 24 August 2023.

III.3.b. Draft investment portfolios

The next step was to assemble the prioritised district Type 2 measures into draft investment portfolios, covering the three districts. These provisional versions were to be discussed during the next national-level consultation. Four portfolio options were prepared:

- Portfolio 1, small budget: pools all the district measures together and includes those with the highest weighted scores until the total investment amount of USD 67 million is met.
- Portfolio 2, large budget: same approach as for portfolio 1 but with a total investment cost of USD 203 million.
- Portfolio 3, equal number of measures per district: includes the top three prioritised measures for each district, for a total investment cost of USD 153 million.
- Portfolio 4, equal investment per district: includes three measures per district, making a total investment per district close to USD 40 million, starting from the top prioritised measures in each district, for a total investment cost of USD 123 million.

Annexe 2 describes the draft portfolios.

III.4. Consultation at the national level: finalisation and prioritisation of Type 2 adaptation portfolios

A second round of consultations was conducted at the national level to finalise and prioritise the Type 2 adaptation portfolios. This was done in two steps: first, with a workshop, assembling high-level government officials and the ADB, and second, with a final individual consultation with the MWR.

III.4.a. Workshop

The workshop was organised at the national level in Tashkent on the 20th of October 2023. It aimed to collect feedback from government officials on the four proposed portfolios of adaptation investments. The ADB actively participated in this meeting.

The main activities were to:

- Discuss and modify, when needed, the draft investment portfolios in breakout groups. Readjustments were proposed within the portfolios, such as merging, modifying or deleting measures. Representatives of the Scientific Information Center of the Interstate Commission for Water Coordination of Central Asia (SIC ICWC) also proposed a series of accompanying measures to the portfolios.

- Vote for the preferred revised portfolios. The amended Portfolio 3, which contains an equal number of measures per district, emerged as the preferred portfolio, for a total investment cost of USD 206 million. Annexe 3 describes the amended Portfolio 3.

More details on the process can be found in the report "Workshop: Adaptation Options in Amu Darya River Basin, Tashkent, 20 October 2023".

III.4.b. Final individual meeting with the MWR

An individual consultation was held in November 2023 with the Center for the Implementation of Foreign Investment Projects for Water Management (CIFIPWM) of the MWR. The objective was to validate the output from the national workshop, namely:

- The amended Portfolio 3, equal number of measures per district, should be selected.
- Accompanying measures suggested by the SIC ICWC should also be retained, as they align with existing national strategies and guidelines (e.g., Water Concept 2030, Water Strategy).

This consultation also brought additional information to develop the amended Portfolio 3:

- The MWR should not be solely in charge of implementing the Type 2 portfolio's measures. Identification of other responsible organisations should be based on the theme of each measure. Each responsible organisation should be solely in charge of implementation to avoid delays due to necessary cooperation and discussions among many bodies.
- Based on previous consultations at district and national levels, the consultants of this Assignment suggested the organisations responsible for implementing the different measures. This responsibility was validated (see Annexe 3).
- The CIFIPWM also advised that measures directly aligned with the Water Concept 2030 and Water Strategy have the highest priority and should be implemented in the short and medium terms.

IV. Task 3: Identification of priority measures and portfolios

Task 3 builds on the previous Task 2, in which a portfolio of Type 2 adaptation measures has been identified for investment by the government of Uzbekistan. The first step in this task ensured that the portfolio is aligned with Uzbekistan's major national and sectoral processes. Lastly, a pre-concept note was drafted for financing and implementing the portfolio of Type 2 adaptation measures.

IV.1. Alignment with existing and ongoing national and sectoral processes, strategies and plans

The alignment with Uzbekistan's NDC was ensured right from the beginning by considering this document while defining the list of possible Type 2 measures, to be discussed with the stakeholders (see sub-section III.1.a above). The last individual consultation with the MWR also made sure that the proposed portfolio is consistent with the Water Concept 2030 and Water Strategy (see sub-section III.4.b above). Lastly, it was also verified that the portfolio is aligned with Uzbekistan's Green Economy Strategy.

Synergies with ADB's priorities for cooperation with the government of Uzbekistan were also duly considered. ADB has been supporting the drafting of Uzbekistan's Water Strategy, so the Bank implicitly agrees with this document, with which the proposed portfolio is aligned. The consultants of this Assignment also maintained regular consultations with the ADB, and the Bank actively participated in the different stakeholder consultations. Therefore, ADB has followed the identification and definition of the selected portfolio, and agrees with its content. This ensures that the chosen portfolio is suitable for ADB investment and the development of a pre-concept note

IV.2. Preparing a pre-concept note for implementing the selected investment portfolio

The pre-concept note for the chosen portfolio was drafted to put it on track for ADB financing. The note actually argued for establishing the Uzbekistan Amu Darya Adaptation Facility (ADAF), to fund adaptation investments, including the chosen portfolio identified by this Assignment.

The main content of the pre-concept note is:

- Introduction and Rationale for climate change adaptation in Uzbekistan, including existing national strategies and processes for adaptation, and the climate risk analysis accomplished in Task 1.
- Summary of main gaps and barriers to climate financing. It emphasised the insufficient participation of the private sector and suggested investigating the introduction of Public-Private Partnership (PPP) mechanisms in Uzbekistan.
- Suggestion to set up The Uzbekistan Amu Darya Adaptation Facility (ADAF), under the MWR, to address the barriers identified above. The Facility would provide funding for identified and new adaptation investments, including the investment portfolio defined in this Assignment. It would manage both traditional public investments and PPPs. Four outputs are presented for the ADAF: Output 1: Adaptation investment pipeline developed and extended; Output 2: Adaptation investments implemented; Output 3: Capacity built for adaptation in the water sector; Output 4: PPP and market-based mechanisms for adaptation investments and operations in the water sector built, piloted and rolled out.
- An initial amount of USD 500 million is suggested for the Facility. Funding is expected from blended climate and development international financing sources, including the ADB (OCR concessional loan and ADF grant) and ADB trust funds (grant). Through its Output 4, the Facility will also leverage financial contributions from the private sector.
- A Technical Assistance is proposed to support establishing the ADAF, executed and implemented by the MWR.

The final definition of the selected portfolio, presented in the pre-concept note, is placed in Annexe 4. More details can be found in the report “Pre-concept note: Uzbekistan Amu Darya Adaptation Facility”.

Annexe 1: Standalone reports produced during the Assignment

- Climate Change Risk Mapping of the Amu Darya river basin, Uzbekistan.
- Report on Results of Online Survey conducted in 15 Districts of 7 Regions in Amu Darya River Basin of the Republic of Uzbekistan.
- Report on Field Survey Results for Kitab District Kashkadarya Region.
- In-depth Surveys Conducted in Konlikul District of the Republic of Karakalpakstan and Gurlan District of the Khorezm Region.
- Workshop: Adaptation Options in Amu Darya River Basin in Kitab, 12-13 April 2023.
- Workshop: Adaptation Options in Amu Darya River Basin in Gurlan, 17 August 2023.
- Workshop: Adaptation Options in Amu Darya River Basin in Kanlikul, 24 August 2023.
- Workshop: Adaptation Options in Amu Darya River Basin, Tashkent, 20 October 2023.
- Pre-concept note: Uzbekistan Amu Darya Adaptation Facility.

Annexe 2: Draft investment portfolios

Portfolio 1, small budget

The portfolio was constructed by pooling all district Type 2 measures and their MCDA scores, ranking them from highest to lowest scores, and picking from the top down till the targeted investment range of USD 67 million was reached. The drawback of this portfolio is that it is very much skewed towards Kitab.

Rank	Score	District	Number	Measure	Est. cost (million $)
1	61.9	Kitob	WS1-10	Implement ecosystem-based adaptation to protect, maintain, and restore degraded habitats with active involvement of local community.	11.9
2	59.8	Kitob	WS1-6	Improve flood protection such as construction of reservoirs, construction of dikes, construction of eco-based solutions, etc.	11.1
3	59.8	Kitob	WS1-8	Promote conservation agriculture (e.g. organic, biodynamic, zero and minimum/ conservation tillage, fallow practices, etc.).	10.4
4	58.0	Kitob	WS1-9	In order to provide (production of) value-added products, sustainable pasture management, improve fodder production and transfer small ruminants from open pastures to breeding on farms, formation of controlling public cooperatives.	8.7
5	57.3	Kitob	WS1-7	Change to more drought, salt and heat resistant crops on the area of … ha, as well as heat resistant animals and animal species in animal husbandry.	8.4
6	56.7	Kanlikul	WS3-7	Create a new cropping pattern system with more salt-resistant, drought-resistant and heat-resistant crops and organise pilot plots to demonstrate their results. Cropping pattern system established on 1000 ha with pilot plots of 100 ha to systematically measure the impact.	11.4
7	55.9	Kitob	WS1-4	Implement water irrigation saving technologies, such as drip, sprinkler and night irrigation, based on accurate research, taking into account the impact on the environment.	10.3
8	55.6	Kitob	WS1-5	Improve Early Warning Systems.	8.4
9	55.6	Kitob	WS1-1	Enhance water storage capacity in natural dams and water retention systems.	8.2
10	54.7	Kitob	WS1-3	Enhance performance and efficiency of water utilities through technological improvements and capacity development for reducing water loss.	8.0
11	54.4	Gurlan	WS2-9	Develop a system of agricultural inputs supply for farmers covering all farmers	0.01

Portfolio 2, large budget

The approach was the same as for Portfolio 1, with a larger budget of USD 153 million. As is the case with portfolio 1, it is it is very much skewed towards Kitab.

Rank	Score	District	Number	Measure	Est. cost (million $)
1	61.9	Kitob	WS1-10	Implement ecosystem-based adaptation to protect, maintain, and restore degraded habitats with active involvement of local community.	11.9
2	59.8	Kitob	WS1-6	Improve flood protection such as construction of reservoirs, construction of dikes, construction of eco-based solutions, etc.	11.1
3	59.8	Kitob	WS1-8	Promote the use of conservation agriculture (e.g. organic, biodynamic, zero and minimum/ conservation tillage, fallow practices, etc.).	10.4
4	58.0	Kitob	WS1-9	In order to provide (production of) value-added products, sustainable pasture management, improve fodder production and transfer small ruminants from open pastures to breeding on farms, formation of controlling public cooperatives.	8.7
5	57.3	Kitob	WS1-7	Changing to more drought, salt and heat resistant crops and crop species on the area of … ha, as well as heat resistant animals and animal species in animal husbandry.	8.4
6	56.7	Kanlikul	WS3-7	Create a new cropping pattern system with more salt-resistant, drought-resistant and heat-resistant crops and organise pilot plots to demonstrate their results. Cropping pattern system established on 1000 ha with pilot plots of 100 ha to systematically measure the impact.	11.4
7	55.9	Kitob	WS1-4	Implementation of irrigation schemes, water-saving technologies, such as drip, sprinkler and night irrigation, based on accurate research, taking into account the impact on the environment.	10.3
8	55.6	Kitob	WS1-5	Improve Early Warning Systems.	8.4
9	55.6	Kitob	WS1-1	Enhancing water storage capacity in natural dams and water retention systems.	8.2
10	54.7	Kitob	WS1-3	Enhancing performance and efficiency of water utilities through technological improvements and capacity development for reducing water loss.	8.0
11	54.4	Gurlan	WS2-9	Develop a system of agricultural inputs supply for farmers covering all farmers	0.01
12	54.2	Kanlikul	WS3-1	Build new and rehabilitate existing water supply and sewage systems, equipping them with special machinery and equipment (coverage of 50,000 consumers, building new and rehabilitate drinking and sewer networks and pumping stations, expansion of treatment facilities)	73.0
13	54.2	Gurlan	WS2-2	Implement modern techniques and technologies for soil cultivation and irrigation (on the area of 5000 ha): deep loosening, laser planning of field, use of flexible pipelines and discrete irrigation	4.2
14	53.4	Kanlikul	WS3-3	Rehabilitate irrigation networks, including: 71 km of inter-farm canals and 500 km of on-farm canals.	30.0

Portfolio 3, equal number of measures per district

The portfolio was constructed by ranking, in each district, the Type 2 measures according to their MCDA scores, from highest to lowest scores, and taking the top 3 measures. The investment is more fairly distributed over the districts, although Kanlikul would receive most of the investments.

Rank	Score	District	Number	Description of the option / investment measure	Est. cost (million $)
6	56.7	Kanlikul	WS3-7	Create a new cropping pattern system with more salt-resistant, drought-resistant and heat-resistant crops and organise pilot plots to demonstrate their results. Cropping pattern system established on 1000 ha with pilot plots of 100 ha to systematically measure the impact.	11.4
12	54.2	Kanlikul	WS3-1	Construction of new and reconstruction of existing water supply and sewage systems, equipping them with special machinery and equipment (coverage of 50,000 consumers, construction and reconstruction of drinking and sewer networks and pumping stations, expansion of treatment facilities)	73.0
14	53.4	Kanlikul	WS3-3	Reconstruction of irrigation networks, including: 71 km of inter-farm canals and 500 km of on-farm canals.	30.0
11	54.4	Gurlan	WS2-9	Develop a system of agricultural inputs supply for farmers covering all farmers	0.01
13	54.2	Gurlan	WS2-2	Implementation of modern techniques and technologies for soil cultivation and irrigation (on the area of 5000 ha): deep loosening, laser planning of field, use of flexible pipelines and discrete irrigation	4.2
19	50.9	Gurlan	WS2-10	Establish cooperation between farms and clusters and Uzgidromet. (provision of meteorological and agrometeorological data, establishment of mini-meteorological stations)	0.01
1	61.9	Kitob	WS1-10	Implement ecosystem-based adaptation to protect, maintain, and restore degraded habitats with active involvement of local community.	11.9
2	59.8	Kitob	WS1-6	Improve flood protection such as construction of reservoirs, construction of dikes, construction of eco-based solutions, etc.	11.1
3	59.8	Kitob	WS1-8	Promote the use of conservation agriculture (e.g. organic, biodynamic, zero and minimum/ conservation tillage, fallow practices, etc.).	10.4

Portfolio 4, equal investment per district

The portfolio was constructed by ranking, in each district, the Type 2 measures according to their MCDA scores, from highest to lowest scores, and taking for each district the highest ranked measures until the target investment range of USD 40 million per district was reached, skipping measures that would imply exceeding this amount. The investment is more fairly distributed over the districts.

Rank	Score	District	Number	Description of the option / investment measure	Est. cost (million $)
6	56.7	Kanlikul	WS3-7	Create a new cropping pattern system with more salt-resistant, drought-resistant and heat-resistant crops and organise pilot plots to demonstrate their results. Cropping pattern system established on 1000 ha with pilot plots of 100 ha to systematically measure the impact.	11.4
14	53.4	Kanlikul	WS3-3	Reconstruction of irrigation networks, including: 71 km of inter-farm canals and 500 km of on-farm canals.	30.0
11	54.4	Gurlan	WS2-9	Develop a system of agricultural inputs supply for farmers covering all farmers	0.01
13	54.2	Gurlan	WS2-2	Implementation of modern techniques and technologies for soil cultivation and irrigation (on the area of 5000 ha): deep loosening, laser planning of field, use of flexible pipelines and discrete irrigation	4.2
19	50.9	Gurlan	WS2-10	Establishment of cooperation between farms and clusters and Uzgidromet. (provision of meteorological and agrometeorological data, establishment of mini-meteorological stations)	0.01
22	49.6	Gurlan	WS2-5	Create a new cropping pattern system with more salt-resistant, drought-resistant and heat-resistant crops and organise pilot plots to demonstrate their results. Cropping pattern system established on 1000 ha with pilot plots of 100 ha to systematically measure the impact.	10.3
23	49.5	Gurlan	WS2-6	Develop 200 hectares of greenhouses where drip irrigation, hydrogel and hydroponic techniques will be used	5.4
24	49.5	Gurlan	WS2-12	Develop technologies for reducing the salinity of collector-drainage waters for their subsequent use in irrigation	20.0
1	61.9	Kitob	WS1-10	Implement ecosystem-based adaptation to protect, maintain, and restore degraded habitats with active involvement of local community.	11.9
2	59.8	Kitob	WS1-6	Improve flood protection such as construction of reservoirs, construction of dikes, construction of eco-based solutions, etc.	11.1
3	59.8	Kitob	WS1-8	Promote the use of conservation agriculture (e.g. organic, biodynamic, zero and minimum/ conservation tillage, fallow practices, etc.).	10.4
4	58.0	Kitob	WS1-9	In order to provide (production of) value-added products, sustainable pasture management, improve fodder production and transfer small ruminants from open pastures to breeding on farms, formation of controlling public cooperatives.	8.7

Annexe 3: Amended Portfolio 3, equal number of measures per district

The following amended Portfolio 3 was selected as the preferred investment package during the national-level workshop. Individual consultation with the MWR also validated the suggestion for the responsible organisations.

Rank	Score	District	Number	Description of the option / investment measure	Contribution during the workshop	Est. cost (million $)	Responsible
6	56.7	Kanlikul	WS3-7	Create a new cropping pattern system with more salt-resistant, drought-resistant and heat-resistant crops and organise pilot plots to demonstrate their results. Cropping pattern system established on 1000 ha with pilot plots of 100 ha to systematically measure the impact.	Direct necessity to adapting to climate change. Heat-resistant and drought-resistant crops can help mitigate the impacts of climate change by maintaining agricultural productivity even in challenging conditions.	11.4	Ministry of agriculture
12	54.2	Kanlikul	WS3-1	Build new and rehabilitate existing water supply and sewage systems, equipping them with special machinery and equipment (coverage of 50,000 consumers, building new and rehabilitate drinking and sewer networks and pumping stations, expansion of treatment facilities)	Renovating aging infrastructure will significantly reduce water losses due to leaks and inefficient distribution systems. This conserves water resources, contributes to climate change resilience, reduces the need for excessive pumping and treatment, and lowers energy consumption, all of which contribute to mitigating GHG emissions.	73.0	UzSuvTa'minot
14	53.4	Kanlikul	WS3-3	Reconstruction of irrigation networks and Pump Stations, including: 71 km of inter-farm canals and 500 km of on-farm canals.	It will allow reducing water loss and increase the efficiency of its delivery.	57.7	Ministry of water resources
13	54.2	Gurlan	WS2-2	Implementation of modern techniques and technologies for soil cultivation and irrigation (on the area of 5000 ha): deep loosening, laser	Will allow using water and land more efficiently in conditions of changing climate	4.2	Ministry of water resources OR Ministry of agriculture

Rank	Score	District	Number	Description of the option / investment measure	Contribution during the workshop	Est. cost (million $)	Responsible
				planning of field, use of flexible pipelines and discrete irrigation			
19	50.9	Gurlan	WS2-9 + WS2-10	Development of a system for the supply of agricultural products, early warning, and information exchange with Hydromet for farmers	Each farmer or cluster can be prepared themselves for climatic conditions	9.2	Ministry of Agriculture OR UzHydromet
1	61.9	Kitob	WS1-10	Implement ecosystem-based adaptation to protect, maintain, and restore degraded habitats with active involvement of the local community.	Will allow saving ecosystems and restoring degraded natural resources.	11.9	Ministry of ecology, environment protection and climate change
2	59.8	Kitob	WS1-6	Improving flood protection through implementing measures such as the construction of closed underground reservoirs, dams, environmental structures, mini-hydroelectric power plants and others.	Will allow protecting population, their assets and land against floods. It will also guarantee the access to water. Ecosystems will be protected in the process.	28.5	Ministry of water resources
3	59.8	Kitob	WS1-8	Promote the use of conservation agriculture (e.g. organic, biodynamic, zero and minimum/ conservation tillage, fallow practices, etc.).	Will allow protecting and saving water and land resources. It will also strengthen food security.	10.4	Ministry of agriculture

Annexe 4: Selected investment porttfolio (amended Portfolio 3, equal number of measures per district)

District	Description of the option/investment measure	Adaptation contribution	Est. investment (million $)
Ministry of Water Resources			
Kanlikul	Reconstruction of irrigation networks and Pump Stations, including: 71 km of inter-farm canals and 500 km of on-farm canals.	Will allow decreasing water losses and increasing the efficiency of its delivery	57.7
Gurlan	Implementation of modern techniques and technologies for soil cultivation and irrigation (on the area of 5000 ha): deep loosening, laser planning of field, use of flexible pipelines and discrete irrigation.	Will allow using water and land more efficiently in conditions of changing climate	4.2
Kitob	Improving flood protection through the implementation of measures such as the construction of closed underground reservoirs, dams, environmental structures, mini-hydroelectric power plants and others.	Will allow protecting population, their assets and land against floods. Will also guarantee water access. Ecosystems will be protected in the process.	28.5
Ministry of Agriculture			
Kanlikul	Create a new cropping pattern system with more salt-resistant, drought-resistant and heat-resistant crops and organise pilot plots to demonstrate their results. Cropping pattern system established on 1000 ha with pilot plots of 100 ha to systematically measure the impact.	Direct necessity to adapt to climate change. Heat-resistant and drought-resistant crops can help mitigate the impacts of climate change by maintaining agricultural productivity even in challenging conditions.	11.4
Gurlan	Development of a system for the supply of agricultural products, early warning, and information exchange with Hydromet for farmers	Each farmer or cluster can be resilient to changing climatic conditions	9.2
Kitob	Promote conservation agriculture (e.g. organic, biodynamic, zero and minimum/ conservation tillage, fallow practices, etc.).	Will allow protecting and saving water and land resources. Will strengthen food security.	10.4
			UzSuvTa'minot

District	Description of the option/investment measure	Adaptation contribution	Est. investment (million $)
Kanlikul	Build new and rehabilitate existing water supply and sewage systems, equipping them with special machinery and equipment (coverage of 50,000 consumers, building new and rehabilitate drinking and sewer networks and pumping stations, expansion of treatment facilities)	Renovating ageing infrastructures will significantly reduce water losses due to leaks and inefficient distribution systems. This conserves water resources, contributing to climate change resilience. It also reduces the need for excessive pumping and treatment, contributing to mitigating GHG emissions.	73.0
Ministry of ecology, environment protection and climate change			
Kitob	Implement ecosystem-based adaptation to protect, maintain, and restore degraded habitats with active involvement of local community.	Will allow saving ecosystems and restoring degraded natural resources.	11.9