Dutch Disaster Risk Reduction & Surge Support (DRRS) Programme

Collaboration on Flood Risk Management - Kazakhstan

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Contents

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List of abbreviations

API	Application Programming Interface: a software intermediary that allows applications to talk to each other
DRRS	Disaster Risk Reduction & Surge Support
EW	Early Warning
FEWS	Flood Early Warning System
FRM	Flood Risk Management
MoU	Memorandum of Understanding
UNDP	United Nations Development Programme
UNDRR	United Nations Office for Disaster Risk Reduction

EXECUTIVE SUMMARY

In April 2024, Kazakhstan faced severe flooding that prompted the Kazakh government to seek international assistance. The Dutch government responded immediately, deploying the Disaster Risk Reduction & Surge Support (DRRS) team to assist during the emergency phase, and to support Kazakh authorities in devising an Action Plan aimed at strengthening Flood Risk Management (FRM) in the country.

As part of the Action Plan, follow-up collaborations took place during three dedicated 1-week periods (August 26-30, October 21-25, November 4-8), focusing on knowledge exchange and working with innovative technologies in FRM. These Collaboration weeks included lectures, discussions, and hands-on exercises centered on the Delft Flood Early Warning System (Delft-FEWS) and flood modeling tools tailored to Kazakh scenarios. The key objectives were to enhance operationalization of FRM technologies and provide practical experience with advanced modeling techniques.

The collaboration weeks strengthened ties between Kazakh and Netherlands flood management experts, and revealed a strong ambition among Kazakh authorities to improve FRM. This report provides an overview of the completed collaborative activities and, as part of a jointly developed roadmap, proposes key follow-up actions:

1. Operationalizing Delft-FEWS: The primary recommendation is to prioritize the operationalization of the Delft-FEWS. This initiative will address technical, capacity, and institutional needs, ensuring effective flood management and enhanced forecasting capabilities. Priority technical components of a Delft-FEWS system for Kazakhstan are proposed, including integration of national hydrological data and information from space observation, and expansion of hydrological modelling.

ИСПОЛНИТЕЛЬНОЕ РЕЗЮМЕ

В апреле 2024 года Казахстан столкнулся с сильным наводнением, которое побудило правительство Казахстана обратиться за международной помощью. Правительство Нидерландов незамедлительно отреагировало , развернув группу по снижению риска стихийных бедствий и экстренной поддержке (DRRS) для оказания помощи в чрезвычайной ситуации и поддержки властей Казахстана в разработке Плана действий, направленного на укрепление управления рисками наводнений (УРН) в стране.

В рамках Плана действий последующие совместные мероприятия проводились в течение трех специальных однонедельных периодов (26-30 августа, 21-25 октября, 4-8 ноября), уделяя особое внимание обмену знаниями и работе с инновационными технологиями в УРН. Эти недели сотрудничества включали лекции, обсуждения и практические занятия посвященные по системе раннего предупреждения о наводнениях Delft-FEWS и инструментам моделирования наводнений, адаптированным к казахстанским сценариям. Основными целями были улучшение операционализации технологий УРН и предоставление практического опыта работы с передовыми методами моделирования.

Недели сотрудничества укрепили связи между экспертами по управлению наводнениями из Казахстана и Нидерландов и выявили сильное стремление властей Казахстана улучшить УРН. В этом отчете представлен обзор состоявшихся совместных мероприятий и, как часть совместно разработанной дорожной карты, предлагаются основные последующие действия:

1. Ввод в действие Delft-FEWS: Основная рекомендация заключается в том, чтобы в первую очередь ввести в использование Delft-FEWS. Эта инициатива будет решать технические, потенциальные и институциональные потребности, обеспечивая эффективное управление наводнениями и расширенные возможности прогнозирования. Предлагаются приоритетные технические компоненты системы Delft-FEWS для Казахстана, включая интеграцию национальных гидрологических данных и информации космических наблюдений, а также расширение гидрологического моделирования.

2. Hazard and Risk Mapping: A comprehensive approach to flood hazard and risk mapping is essential. This will facilitate sustainable planning, infrastructure development, and evacuation strategies, while also addressing technical and capacity-building requirements.

3. Institutional Capacity Development: Strengthening institutional frameworks and inter-ministerial coordination is vital for laying a solid foundation to effective nationwide Flood Risk Management (FRM). Enhanced collaboration among stakeholders, including academia, is needed for effective capacity building, prioritizing developments and alignment of responsibilities, tasks and procedures. Besides continued collaboration among Kazakh authorities and international experts, it is recommended to initiate an interdepartmental working group on Water Security.

2. Картирование опасностей и рисков: Комплексный подход к картированию опасностей и рисков наводнений имеет важное значение. Это будет способствовать устойчивому планированию, развитию инфраструктуры и стратегиям эвакуации, а также решению технических и кадровых требований.

3. Развитие институционального потенциала: Укрепление институциональных рамок и межведомственной координации имеет жизненно важное значение для создания прочной основы для эффективного общенационального управления рисками наводнений. Расширенное сотрудничество между заинтересованными сторонами, включая академические круги, необходимо для эффективного наращивания потенциала, определения приоритетов в разработках и согласования обязанностей, задач и процедур. Помимо продолжения сотрудничества между властями Казахстана и международными экспертами, рекомендуется создать межведомственную рабочую группу по водной безопасности.

1. Introduction

In April 2024 widespread floods occurred across Kazakhstan, causing rivers to burst their banks and inundating cities and towns along their paths. After having already offered support in 2022 with a scoping study on flood management[1], the Dutch government was asked to support the Kazakh government in their emergency response. The Netherlands' Disaster Risk Reduction & Surge Support (DRRS) immediately responded and visited Kazakhstan from April 15-18 to be of service to the Kazakh government during the on-going emergency phase. The support from DRRS included technical advice on the specific flood events that were unfolding, review of the used methods to map and to anticipate on the floods, and an Action Plan for continued Kazakh-Netherlands collaboration. Annex I includes key documents from the emergency response visit, including the official request from Kazakh authorities, the Action Plan, and a Note Verbal with DRRS response to requests from Kazakh authorities (see also Figure 1).

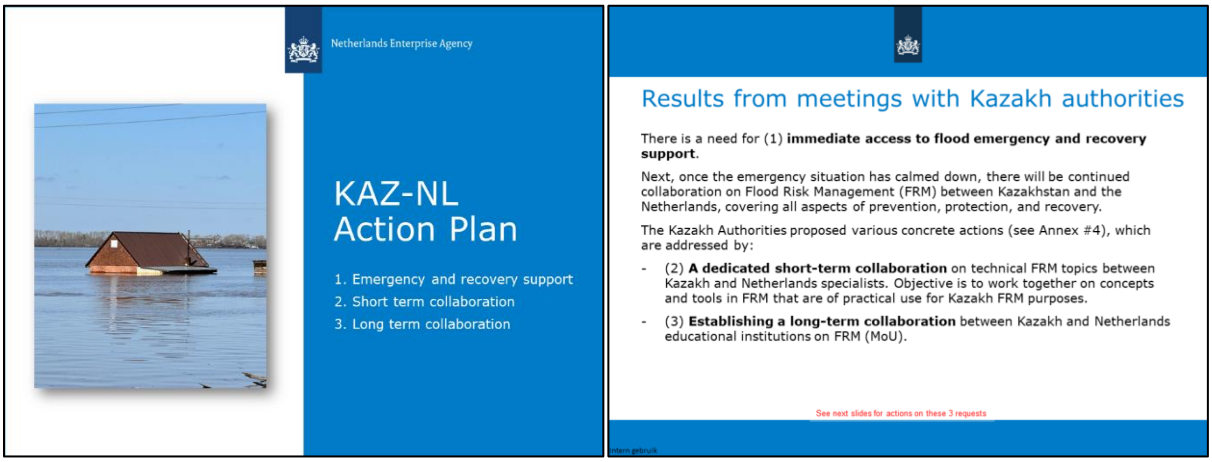

Figure 1: The scoping mission of April 2024 led to an Action Plan for further Kazakh-Netherlands collaboration (see Annex I)

After the visit of April 2024, two Memorandums of Understanding (MoU) were signed that expressed intent for further collaboration on water management with the Kazakh Ministry on Water Resources and Irrigation: one MoU was with the Dutch Ministry of Foreign Affairs and another one with IHE Delft Institute for Water Education, which had a stronger focus on academic collaboration and offering access to various Dutch organizations active in the water sector. In these two MoU's it was agreed to continue collaboration on a variety of water management topics, including aspects related to flood management and associated information technologies.

Central components of the Action Plan were technical collaboration activities between water professionals from Kazakhstan and from the Netherlands. Three 1-week collaboration activities were set up:

- Collaboration week 1 in Astana during dates 26-30 August, 2024;
- Collaboration week 2 in Astana during dates 21-25 October, 2024;
- Collaboration week 3 in Aktobe and Astana during dates 4-8 November, 2024.

[1] Key recommendations included the need for data-driven decision-making tools and guidance on integrated governance through the initiation of an interdepartmental working group.
See: Bosch, R. & M. Zuijderwijk (2022). "DRR-Team: Scoping mission flood management Kazakhstan". DRR222KZ01

This report gives an overview of the participants, programme, the contents, and the outcomes of the three collaboration weeks, and summarizes recommended follow-up steps.

1.1. Focus themes of the technical collaboration

The general approach of the collaboration weeks was to have lectures, discussions, and hands-on exercises in information technologies for diverse aspects in Flood Risk Management (FRM), covering the entire cycle in prevention, preparation, response, recovery, and adaptation (see Figure 2).

Figure 2: Disaster Management Cycle

The collaborations were primarily aimed at technicians from the relevant Kazakh-authorities. However, the general lectures and discussions were also prepared to be useful for policy makers and managers. That way, during these parts authorities were invited to engage in discussions and provide specific input on the needs and requirements in Kazakhstan. All sessions were also broadcasted online for participants from invited Kazakh authorities, the DRRS coordination team in the Netherlands and the strategic advisor from UNDP to Kazakhstan.

1.2. DRRS Team

The DRRS-Team was led by Fredrik Huthoff and held various thematical experts that took part in the four deployments. An overview of participating experts and their involvements is given in Table 1. The DRRS team was locally supported by Netherlands Ambassador Nico Schermers, Dinara Amanturliyeva and Daryn Amanzhan from the Embassy of the Kingdom of the Netherlands to Central Asia in Astana.

Table 1: Deployments of the DRRS team to Kazakhstan in 2024

Team member	**Scoping visit** April 15-18	**Collaboration Week 1** August 26-30	**Collaboration Week 2** October 21-25	**Collaboration Week 3** November 4-8
Fredrik Huthoff Team leader	✓	✓	✓	✓
Henk Nieboer Honorary Consul	✓			
Bas Agerbeek Data analyst	✓ (remote)			
Rieks Bosch Asia water resource expert	✓ (remote)	✓	✓	
Bastian van den Bout Flood modelling expert	✓ (remote)	✓		
Nicole Jungermann		✓	✓	

Team member	Scoping visit April 15-18	Collaboration Week 1 August 26-30	Collaboration Week 2 October 21-25	Collaboration Week 3 November 4-8
Flood forecasting expert				
Marc van Dijk Delft-FEWS expert		✓ (remote)		
Tycho Bovenschen Delft-FEWS expert			✓	
Michel Zuijderwijk Flood management expert				✓
Daan te Witt Hydro-modelling expert				✓
Esmee van de Ridder DRRS coordination team	✓ (remote)	✓ (remote)	✓ (remote)	✓

2. Collaboration week 1 (August - Astana)

Figure 3 shows a group picture of participants in Collaboration week 1, which was held during dates 26-30 August 2024 in Astana. The Terms of Reference of Collaboration week 1 are included in Annex II.

Figure 3: DRRS-Team and Kazakh participants during Collaboration week 1.

2.1. Approach, goals and deliverables

The collaboration week in August 2024 focused on information technologies that can be applied to better anticipate and respond to flood hazard. A concept note including the agenda of the collaboration week is included in Annex III[2]. Specific attention was given to application to Kazakh cases, such that hands-on experience and relevant products could be delivered.

Goals of the collaboration week were:

[2] Note that the mentioned topic of flood adaptation measures was moved to Collaboration week 2.

1. To create appreciation and together develop a plan towards operationalizing innovative Flood Risk Management (FRM) technologies in Kazakhstan, including attention to the institutional setting.
2. To get hands-on experience with Delft-FEWS and flood modelling tools applied to Kazakh cases.

Deliverables were: pilot cases in flood modelling and Delft-FEWS and a preliminary roadmap towards sustainable and effective use of information technologies on FRM in Kazakhstan.

2.2. Exchange of experiences in Flood Risk Management

The first day of Collaboration week 1 focused on exchange of experiences between water professional in Kazakhstan and the Netherlands. A short summary per institution/per presentation is given below. Besides the listed institutions also the United Nations Office for Disaster Risk Reduction (UNDRR) was represented and took part in the discussions.

Ministry of Water Resources and Irrigation

A presentation was given by the head of the department of regulation of water resources (Figure 4). Key challenges are anticipation on filling and optimal regulation of water volumes in reservoirs. During the 2024 floods in Aktobe and Astana the expected water volumes were in reality much exceeded. This also poses questions for needed improvements of reservoir infrastructures and monitoring networks.

Figure 4: Ministry of Water Resources and Irrigation

Institute of Geography and Water Security

Results from SWIM[3] hydrological model for the Zhabay Rver basis are presented (Figure 5). Climate projections are included. Key challenges relate to getting runoff quantities right, for which it is needed to accurately include processes and input data for land cover, rainfall, snowmelt and ground water. Dedicated research programmes need to be set up.

[3] https://www.pik-potsdam.de/en/institute/departments/climate-resilience/models/swim

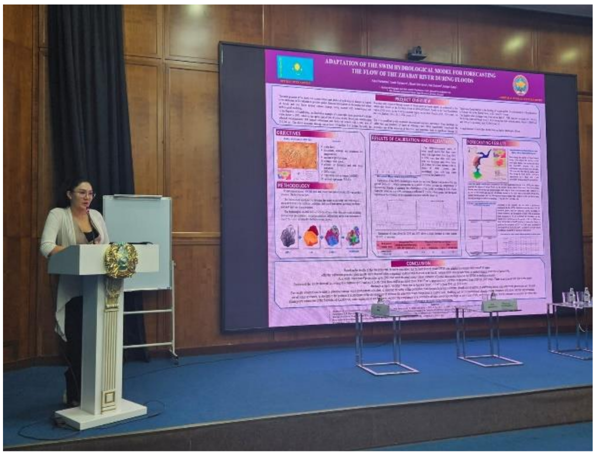

Figure 5: Institute of Geography and water Security.

Ministry of Emergency Situations

Key challenges that were put forward relate to better forecasting of floods and having effective options for water regulation (Figure 6). More monitoring data is needed for better insight into current conditions. Decision support tools are needed to help optimal water regulation, implementation of protection structures and to inform timely emergency actions (prioritizing actions). Emergency procedures are regularly discussed and if needed updated. Intersectoral meetings take place several times per year (once on national level, two or three times per year on regional level).

A particular area of attention is information provision to the general public before, during and after emergencies in order to create improved emergency awareness and associated preparation-and-response actions.

Figure 6: Ministry of Emergency Situations

KazHydroMet

KazHydroMet shares an overview of tasks and responsibilities (Figure 7, left picture) in managing hydro-meteorological data and making weather forecasts, including for extreme hydrological conditions such as floods. Several types of models are being used in Kazakhstan such as HBV[4] and SWMM[5], depending on what is more suitable for a certain area. In general, HBV is used for the open

[4] https://en.wikipedia.org/wiki/HBV_hydrology_model#External_links
[5] https://www.epa.gov/water-research/storm-water-management-model-swmm

plains and SWMM for the mountainous regions in the western part of the country. Satellite and radar data are currently not included as input in the hydrological models.

A flash flood guidance system is operational that provides approximately six hours lead time[6]. Also, for some parts of the country flood hazard maps are available. It is the ambition to improve early warning and to share relevant hydro-meteorological information directly with the public. Therefore, recently a new online platform was launched that contains nationwide data (Figure 7, right picture). The platform includes a function to indicate exceedance of critical thresholds. Also, recently a Task Force for Flood Monitoring was created.

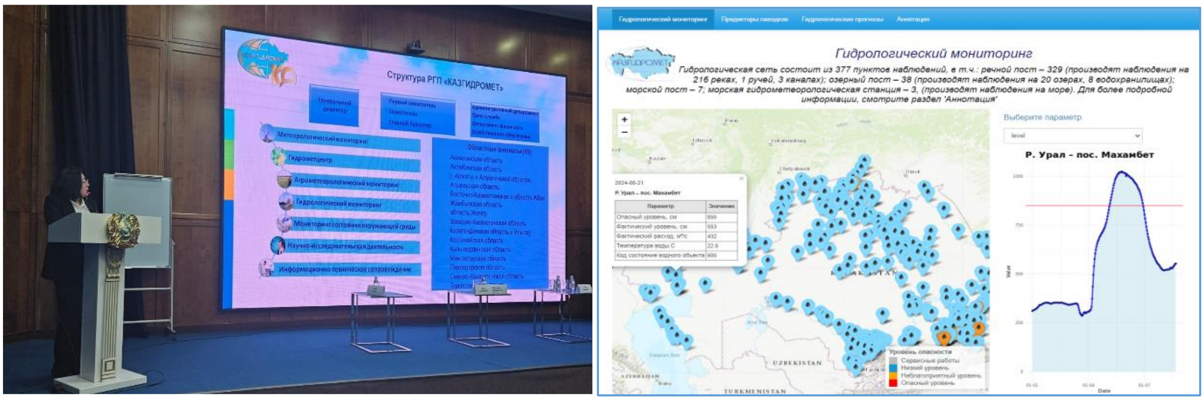

Figure 7: KazHydroMet.presenting its operations, including a demonstration of a new online data platform[7] (right image).

__Gharysh Sapary and KazKosmos__

Gharysh Sapary is Kazakhstan's national space program that operates within the Kazakhstan space agency (also known as "Kazkosmos"). Besides being responsible of national remote sensing data, Gharysh Sapary also runs HEC-RAS[8] flood models for nine river basins. From these models, several flood hazard maps have been created. The return periods of the hazard maps are uncertain, as climate change is disturbing the statistics of hydrological processes. Gharysh Sapary informs the public on national hydrological conditions through its online platform containing hydro-data (see Figure 8). The website contains various static and dynamic datasets. What is still urgently needed is nationwide real-time forecasting of hydrological conditions.

Figure 8: Left: Space Agency, Right: Gharysh Sapary demonstrating its online data platform (https://test-gidro.gharysh.kz/)

[6] https://www.kazhydromet.kz/en/weather/touristic_city_6_hours/481/493
[7] https://www.kazhydromet.kz/interactive_cards or http://ecodata.kz:3838/app_dg_map_ru/
[8] https://www.hec.usace.army.mil/software/hec-ras/

Input for the river basin models at KazKosmos is received from KazHydroMet (from gauging stations and HBV models) and the Ministry of Water Resources and Irrigation (reservoir flow releases), but still many crucial gaps exist in required input data. For example, many basins are ungaged and meltwater is not adequately included. Next developments in flood modelling should focus on expanding flood models to other parts of the country and on improved data input (transboundary information, remote sensing data, runoff in ungauged basins, expansion of national monitoring network).

The output from the models is shared with the Ministry of Emergency Situations to inform emergency actions. Figure 9 gives a schematic overview of the key interagency interactions in the chain going from monitoring to flood forecasting and eventually to emergency actions.

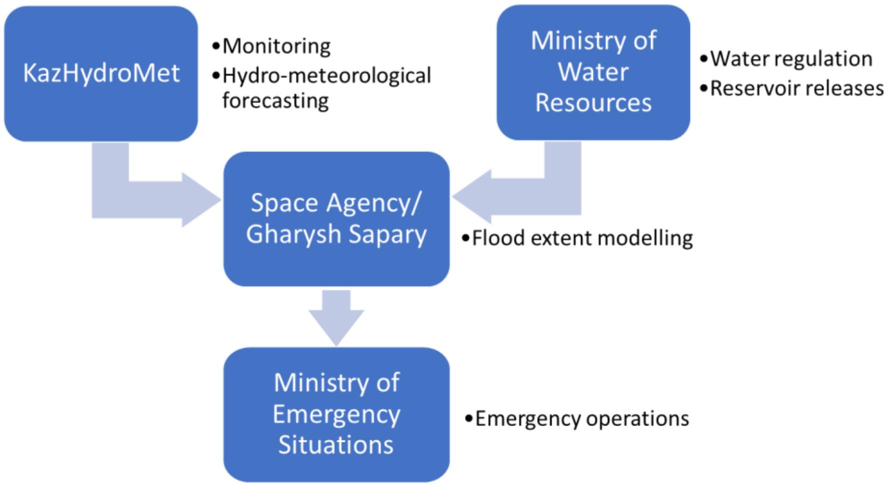

Figure 9: Interagency interactions in flood forecasting and emergency actions.

<u>*Taraz University of Water Management and Irrigation*</u>

A new University of Water Management and Irrigation[9] has been established in 2024 and is starting its work in the city of Taraz in the southern part of the country. A presentation was given by its staff, outlining the plans for educational programs (Figure 10), which will address amongst others the topics: hydraulic engineering in water management, engineering water supply systems, and innovative technologies in water management. Among these, the use and development of information technologies for FRM will be included.

[9] https://www.agroberichtenbuitenland.nl/actueel/nieuws/2024/07/16/kazakhstan-establishes-university-of-water-management-and-irrigation

Figure 10: Taraz University of Water Management and Irrigation.

User storylines

The first day was finalized with an exercise for all participants to summarize their key FRM challenges. In so-called "user storylines", responses were collected using as template the text: "As user [...], my need is [...], because [...]" (see Figure 11). The results from the storylines are summarized in Table 2.

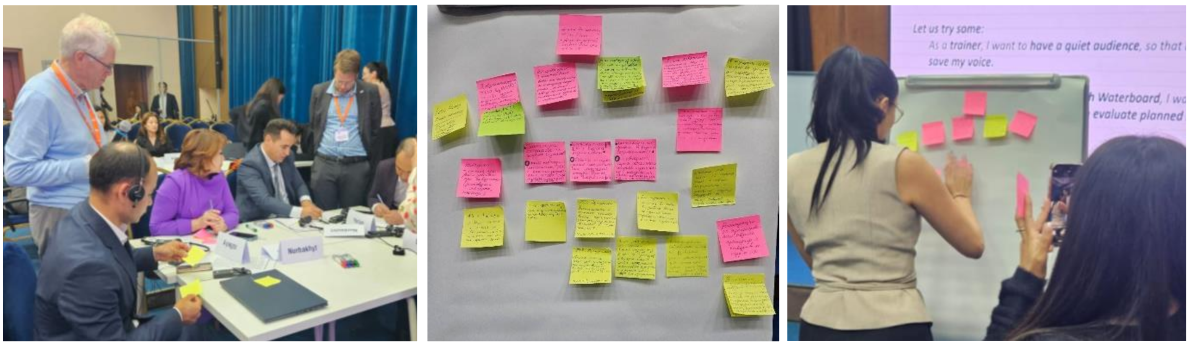

Figure 11: User storylines exercise

Table 2: User storyline responses

User	Need	Because
Kazhydromet	Models for more accurate data and forecasting	Emergency and water regulation
	Improve short-term hydrometeorological weather forecast	
	Access to comprehensive data	Improve modelling
	Information on modelling of regulated basins	
Ministry of Water Resources and Irrigation	Accurate forecasting of water volumes in reservoirs	Effectively regulate distributions for various purposes
	Recommendation on better modelling approaches, including residual snow melt and links to climate change	Manage floods
	Usage of satellite and radar data	Expand model's data input
	Expand gauging station	
	Get forecast of river inflow to reservoirs, including ungauged basin	To manage water volumes better
Ministry of Emergency situations	Have more information from neighbouring countries water flows	Avoid risk
	Algorithm of actions (decision support)	Manage flood emergencies
	Platform that are suitable for forecasting of floods	Forecasting of emergencies
Institute of Geography and Water Security	Accurate DEM, Maps of land, terrain, sources for data. Hydrological data	Model areas of flooding
Taraz National scientific institute	Study Management of flood	Improve infrastructure planning
UNDRR	Better understanding of interagency operation	To implement multi hazard approaches for society
Anonymous	Less theory more practice: vector data, meteo-data, modelling	

From the presentations and the user storylines common responses were that better information on current and future states of water quantities were needed for diverse purposes, ranging from managing emergency situations to improving infrastructure planning.

2.3. Working with information technologies

Lectures, discussions, and hands-on exercises were prepared using software packages FastFlood[10], Delft-FEWS[11] and Talsim[12]. Respective activities are summarized below.

FastFlood modelling exercises

FastFlood is a free online flood modelling tool meant for rapid spatial assessment of flood scenarios. The flood modeling exercises using FastFlood were intended to get hands-on experiences in flood modelling and to help identify where further modelling developments are needed.

Participants engaged in discussions on various modeling techniques and methodologies, and created pilot flood scenarios and maps for areas of their choice (Figure 12). Some of the used example cases are shown in Figure 13. These case studies highlighted the unique challenges faced by different areas, allowing participants to understand the data needs and the value and limitations of hazard mapping for different regions.

Figure 12: Impressions from the FastFlood modelling exercises.

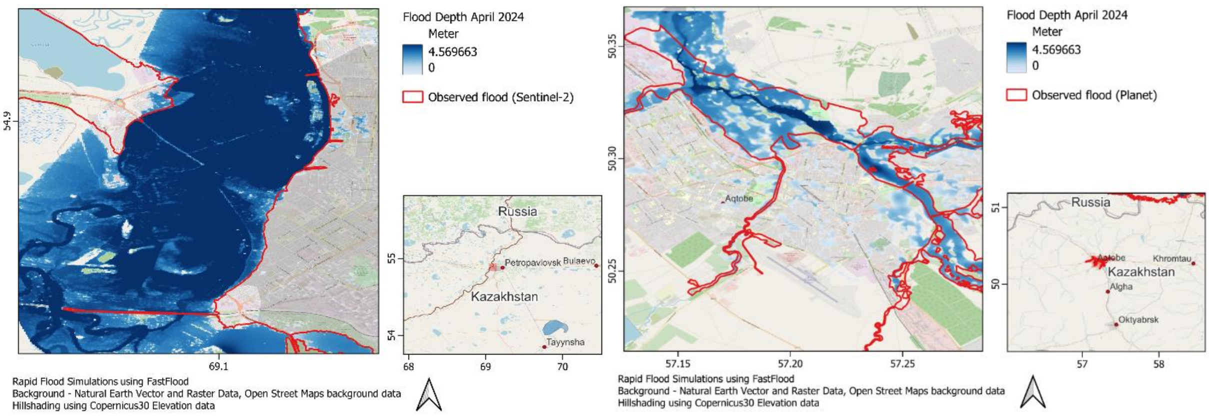

Figure 13: FastFlood example cases (left: Petropavlosk, right: Aktobe).

[10] https://fastflood.org/
[11] https://oss.deltares.nl/web/delft-fews/about-delft-fews
[12] http://www.talsim.de/docs/images/f/f7/TalsimNG_brochure_en.pdf

The flood mapping exercises triggered knowledge sharing and helped identify key areas of attention for improved flood modeling. One such area was near the city of Aktobe, where the joining of rivers creates complex hydrological conditions. With existing monitoring data alone, it is difficult to anticipate flood threats in this area, and therefore more advanced modelling techniques are needed. Aktobe region was prioritized for further modelling and flood mapping investigation in next collaboration activities. It was repeatedly mentioned that improved national flood hazard and risk maps are needed.

Delft-FEWS exercises

The Ministry of Water Resources and Irrigation specifically requested exercises with the software package Delft-FEWS, as they had already selected Delft-FEWS as the preferred tool for upgrading the national data management and forecasting system. The Delft-FEWS exercises spanned three days and included basic configuration steps, analysis of historical hydro-meteorological data, and running a pilot hydrological model to make flood forecasts. A general set-up for a FEWS system in Kazakhstan was also discussed during the sessions, reflecting on types of data-input, relevant involved institutions, data processing steps and linkage to information products and their dissemination (see overview in Figure 14). A further mapping of organizational challenges for such set-up still requires attention.

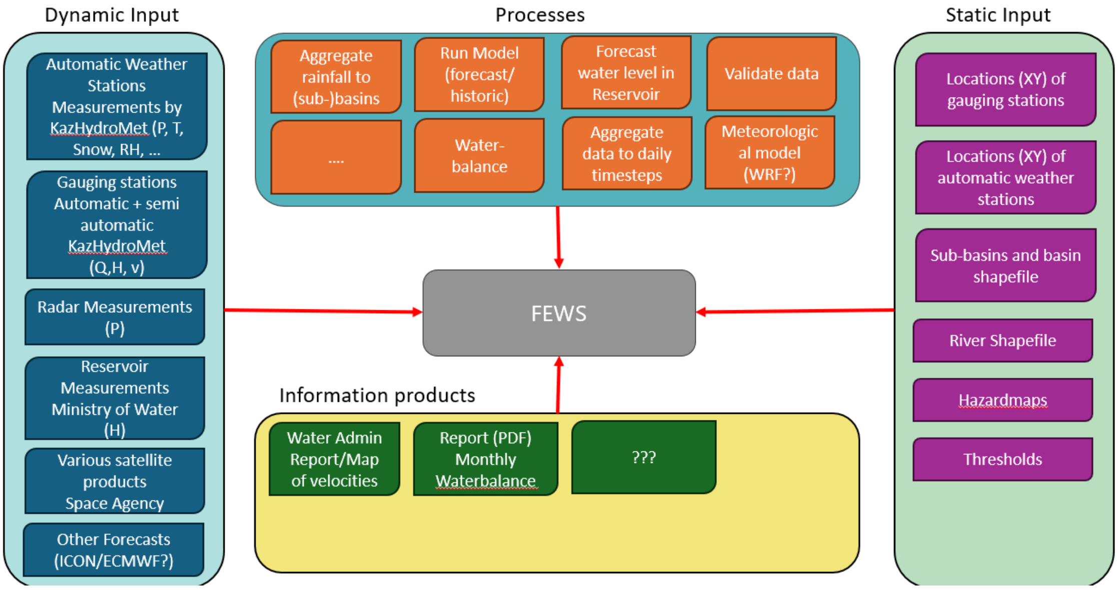

Figure 14: schematic setup of a FEWS system for Kazakhstan.

All participants received a Delft-FEWS installation package, including relevant data and a local hydrological test-model of type Talsim. The model's geographical scope was the Ishim River basin, which includes the city of Astana. The used hydro-meteorological data was selected for the periods before and during the floods of April 2024. The exercise showed possibilities of combining data and models, demonstrating the potential for improved flood anticipation if data and models are properly connected. In addition, an exercise was prepared on reading rainfall data from a recently installed radar station (see Figure 15). It was also discussed how remote sensing technologies could be used to fill data gaps, for example by estimating water storage in cross-boundary reservoirs.

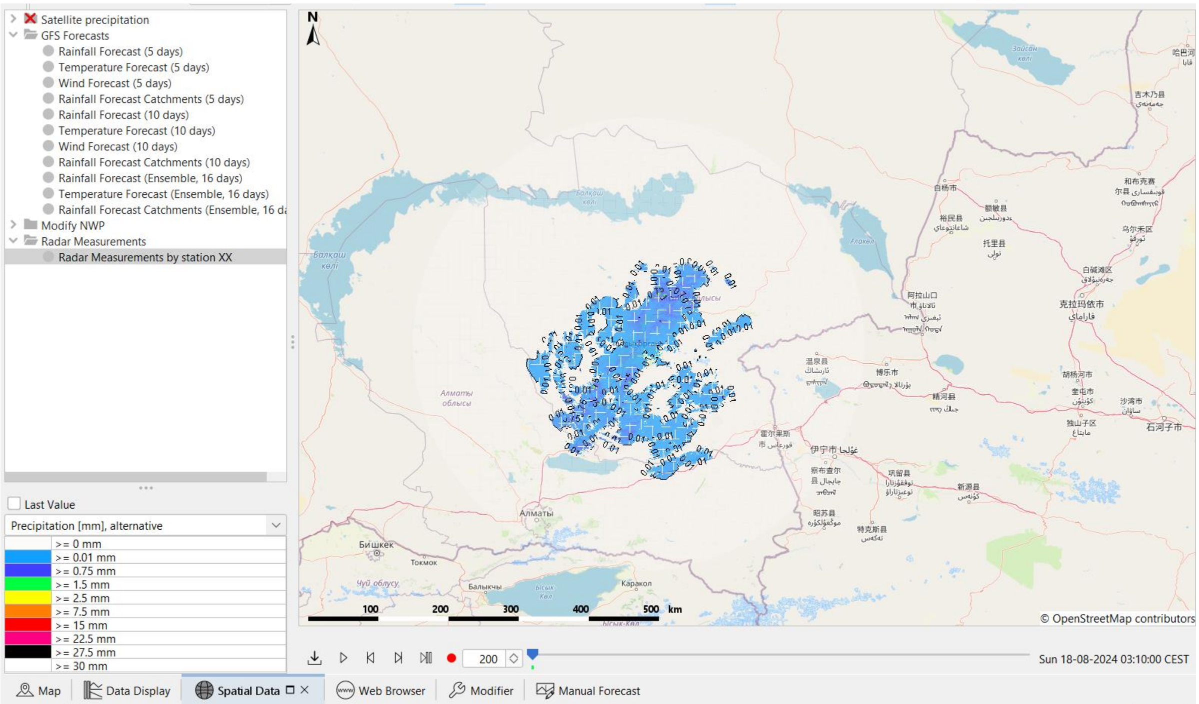

Figure 15: Example data-import from radar station Talditorgan.

Finally, the Delft-FEWS sessions were complemented with a session on dissemination of hydro-meteorological information, where existing practice and potential improvements on information products were discussed. Special attention was given to flood-related products (see Figure 16).

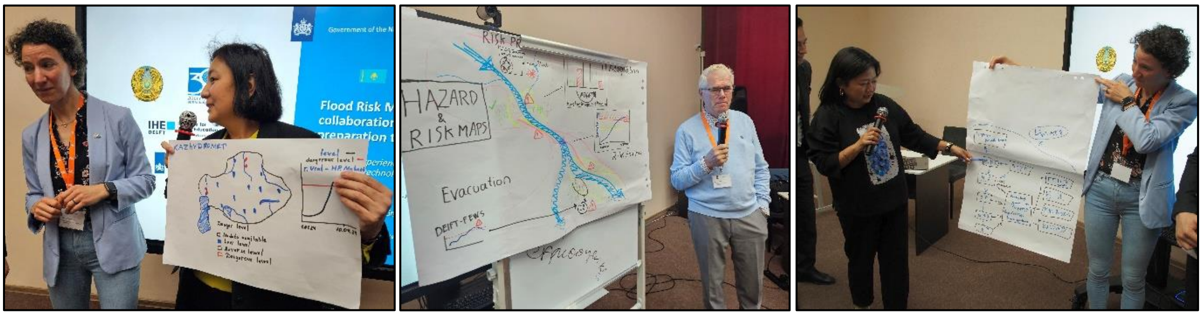

Figure 16: Discussions on improved hydro-meteorological information products.

For follow-up collaboration it was explicitly requested by participants to continue and intensify the exercises on Delft-FEWS, paying specific attention to Delft-FEWS configuration, expansion of included data and widening geographical scope. Interest was expressed for reading and publicly sharing rainfall data from radar stations. Additional priority requests were the need for improved snowmelt and ice monitoring and modelling, and linkage to remote sensing data for observing national and cross-boundary water reservoirs.

2.4. Technological Flood Risk Management approaches in a wider context

Possible technologies and approaches in FRM were also placed in a wider context of water resource management, including attention to climate trends, additional water-related hazards (such as droughts) and the national institutional setting of water planning (see Figure 17). Below, a summary is given of key discussion points.

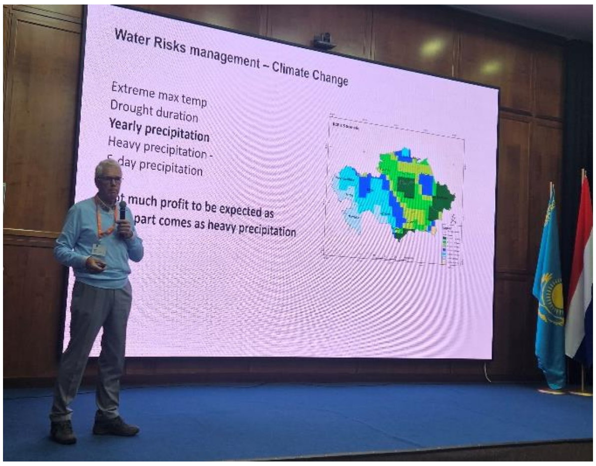

Figure 17: DRRS Team presentation on climate change impacts in the region

Climate and water risks

Water risks in Kazakhstan include several significant hazards, such as flooding, flash floods, drought, and mudflows. These risks pose a complex challenge in Kazakhstan, particularly due to the immense size of the country and the transboundary nature of many of the river basins, which complicates comprehensive monitoring, forecasting and coordinated actions in anticipation or response to extreme situations. Delays and gaps in water information hinder effective planning and decision-making.

Climate change and land degradation increase the frequency and intensity of extreme weather events (see for example Figure 18). There is an increased risk of flooding as seasonal weather trends bring snow melt and spring rain closer together. Land degradation has reduced infiltration rates and runoff protection, exacerbating flood and land erosion. As land quality declines, the environment's ability to manage water diminishes, creating a cycle that worsens both flooding and drought conditions.

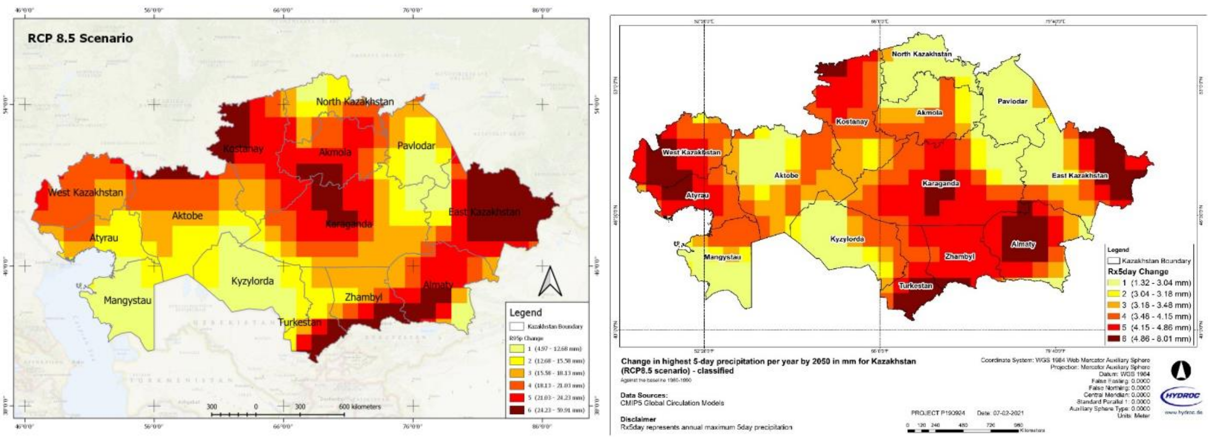

Figure 18: Climate impacts on flood risk in Kazakhstan (RCP 8.5 scenario). Left: Increased extreme rainfall (risk of flash floods and mudflows). Right: Increased 5-day precipitation.

To address these challenges, it is crucial to enhance data sources and fill gaps (global data, remote sensing), translate water data into actionable management information, develop early warning systems, adopt sustainable land management practices, and optimize tools for common planning and decision-making.

Water governance

The current water policy development plans center still much on infrastructure development for improving water management and reducing losses in irrigation systems. There seems insufficient attention to broader water management topics, including reducing risks by investing in prevention, protection and adaptation at the source. However, in a meeting with the first deputy minister and with the vice prime minister such aspects were addressed, and it was emphasized that there is a need for reducing impacts “at the source”, requiring improved forecasting, diverse preventive measures in land use and urban planning, and dedicated attention to reliable (water) infrastructures.

In addition, an **integrated vision** on adaptation to climate change is needed to make water resource management more effective. This may require new legal and regulatory frameworks, to remove potential barriers for effective inter-sectorial collaboration and stimulate implementation of improved procedures, technologies, and methods. For example, the practical use of global or space-based monitoring data could be expanded to fill information gaps and make better informed decisions before and during emergencies. This highlights a broader issue: the lack of common instrumentation and standardized data among involved institutions, which is essential for cohesive preventive action and effective response strategies.

Addressing these gaps requires a comprehensive approach to collaboration among agencies, integrates climate adaptation into planning, and establishes a unified framework for data sharing, modelling and monitoring. To facilitate this, inter-ministerial cooperation is essential, providing a structure for central, high-level coordination. A dedicated water risk working group under the prime minister can streamline communication and decision-making, while a commissioner with authority can ensure accountability and rapid responses to emerging issues.

Potential tasks for the Water Risk working group may include intersectoral information gathering and analyses to understand current challenges, assessing risk prevention strategies, and proposing priorities for action. The group could also focus on developing future scenarios, advising on investments, and evaluating the impacts of climate change on water resources. Especially in changing times there is a need for continual updating of risk assessments. The Water Risk working group could coordinate research and development activities related to hydro-meteorological and flood-extent modelling.

2.5. Preliminary roadmap

From the discussions and interaction during the collaboration week a preliminary roadmap was set up, addressing technological, capacity-building and institutional aspects. In Figure 19 and Table 3 the key results from the participatory roadmap creation are shown, where a distinction is made between short-, medium- and longer-term innovations and developments. See also Annex IV for a larger version of Figure 19.

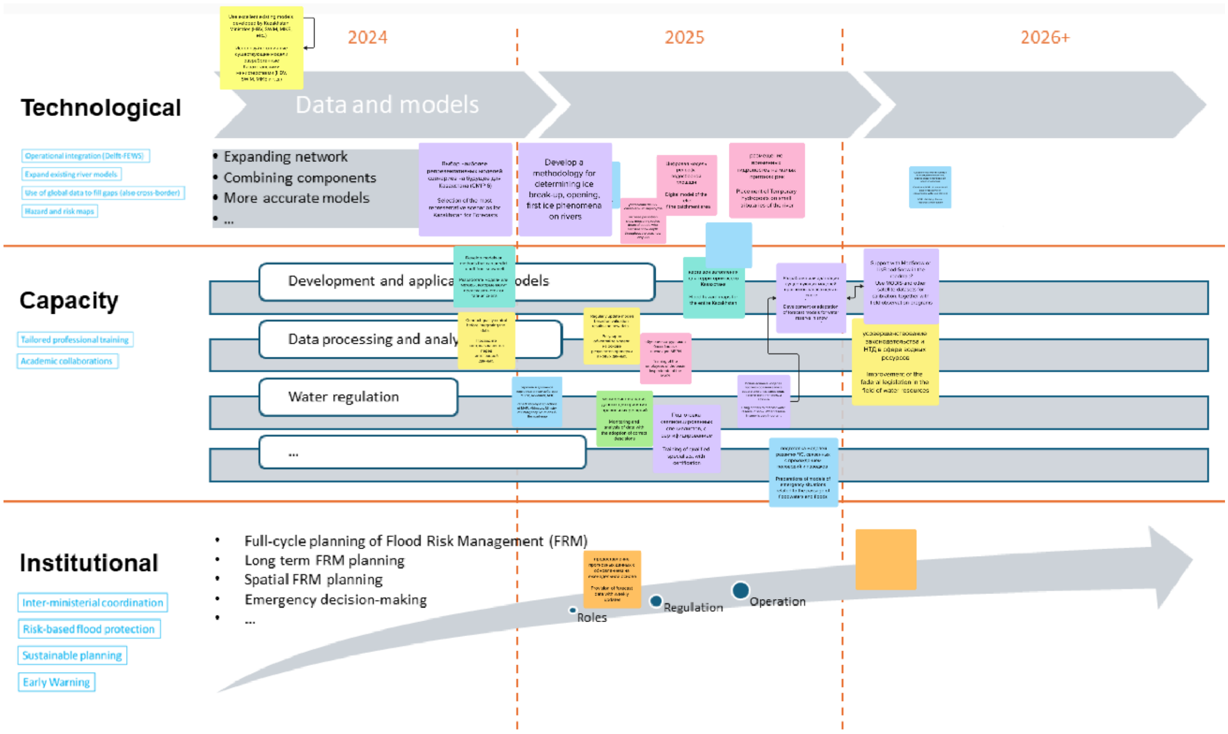

Figure 19: Results from a roadmap exercise where participants posted actions (post-its) on a timeline for technological, capacity, and institutional aspects. Contributions are summarized in Table 3.

Table 3: Roadmap responses from Kazakh participants

For the short term	- Make use of existing hydrological models in operational settings - Identify the most representative flood scenarios (including climate scenarios) - Develop models for runoff from snowmelt - Implement systematic data quality control
For the medium term	- Expand hydro-meteorological monitoring network - Develop methodologies for better treatment of ice-hydrology in models - Develop nation-wide flood hazard maps - Continually validate and update operational models - Expand use of satellite data - Provision of forecast updates to the public - Continue training of specialists in development, application and interpretation of models and data (inform action)
For the longer term	- Create a dedicated centre for all hydro-meteorological data, forecasts, analysis and regulation of water supply and demand

The suggested components for a roadmap on improved FRM in Kazakhstan formed a basis for further discussions and further detailing during Collaboration week 2 in October 2024.

3. Collaboration week 2 (October - Astana)

Figure 20 shows a group picture of participants in Collaboration week 2, which was held during dates 21-25 October 2024 in Astana.

Figure 20: DRRS-Team and Kazakh participants during Collaboration week 2.

3.1. Approach, goals and deliverables

The 2nd Collaboration Week continued with the most urgent actions from the first collaboration week. A concept note for the 2nd collaboration week is included in in Annex V. The central topics were:

1. Continued collaboration in the application of information technologies for improved FRM.
2. Discussions on improved inter-ministerial collaboration, and (technical) exchanges to support FRM in Kazakhstan.

Regarding the continued activities on information technologies in FRM, the focus was on combining data sources and models in Delft-FEWS, with specific attention to inclusion of remote sensing data, radar data and (online) publishing. In addition, a demonstration was given of technologies for flood adaptation planning to reduce flood risk.

3.2. Flood Risk Management concepts and approaches

The actions in Flood Risk Management as listed in Table 3 (from Collaboration week 1) functioned as a general starting point for Collaboration week 2. The voting results by participants shown in Figure 21 reconfirmed the wide support for the listed priority actions. Among these, topics that stood out as a priority were development of hazard and risk maps, and design and implementation of adaptation measures. The concept of a risk-based approach was given specific attention, demonstrating how to combine probabilities of flood events and associated impacts. Also, methods for selecting and designing (cost-) effective flood adaptation measures were addressed. Examples were shared of (static) flood hazard and risk maps, real-time flood risk monitoring in the Netherlands[13] and of

[13] https://www.hkv.nl/projecten/continu-inzicht/

international applications to explore flood adaptation measures[14]. Through these examples, it was discussed how mapping of (probabilities of) hazards and their associated impacts, could serve to make cost-effective decisions in both long-term and in emergency flood-risk reducing strategies.

- Expand hydro-meteorological monitoring network
- Develop nation-wide flood hazard and risk maps
- Improve flood risk reduction works/methods (adaptation)
- Continued training of specialists
- A dedicated centre/working group

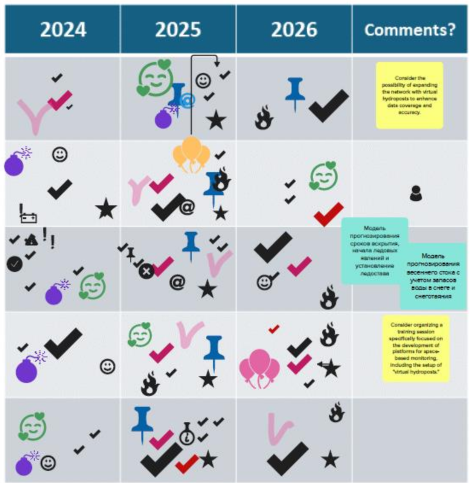

Figure 21: Participatory prioritizing of actions in Flood Risk Management.

Specific comments made in Figure 21 were:

- Modelling is needed for forecasting the timing of ice breakup, the onset of ice phenomena and the establishment of ice cover.
- Consider organizing a training session specifically focused on the development of platforms for space-based monitoring, including the setup of "virtual hydroposts".

3.3. Delft-FEWS

Delft-FEWS exercises were informed by the requests from Collaboration week 1. Delft-FEWS was operated by participants in a ‘standalone’ mode, to allow hands-on experience in the interconnected and consecutive workflows of an operational forecasting system. That way, essential steps in data exchanges, data validations, definitions of alert levels, running a hydrological model, and data processing towards early warning information products were explicitly experienced. Also, the exercises went through the basics of configuring your own FEWS system, from using the User Interface, to adding stations and running workflows. Next, it was discussed how the shown manual steps could be automated in a ‘server-based’ forecasting system that could function operationally.

Specific developments that were covered in the exercises were:
(1) developing an API to read data from KazHydroMet’s monitoring network (see Figure 22),
(2) implementing a hydrological model of the Ishim basin (using Talsim software) to demonstrate forecasting possibilities, also including estimated snow cover from global data sets (see Figure 23),
(3) using Earth observation data for reservoir monitoring (data from Global Water Watch[15] was imported into Delft-FEWS),
(4) incorporating scripts for pre-processing of precipitation data from radar systems (one station from Figure 25 was implemented).

[14] https://www.deltares.nl/en/software-and-data/products/floodadapt
[15] https://www.globalwaterwatch.earth/

Each of these activities yielded (intermediate) products that can be used for implementation in a nationwide Delft-FEWS system for Kazakhstan.

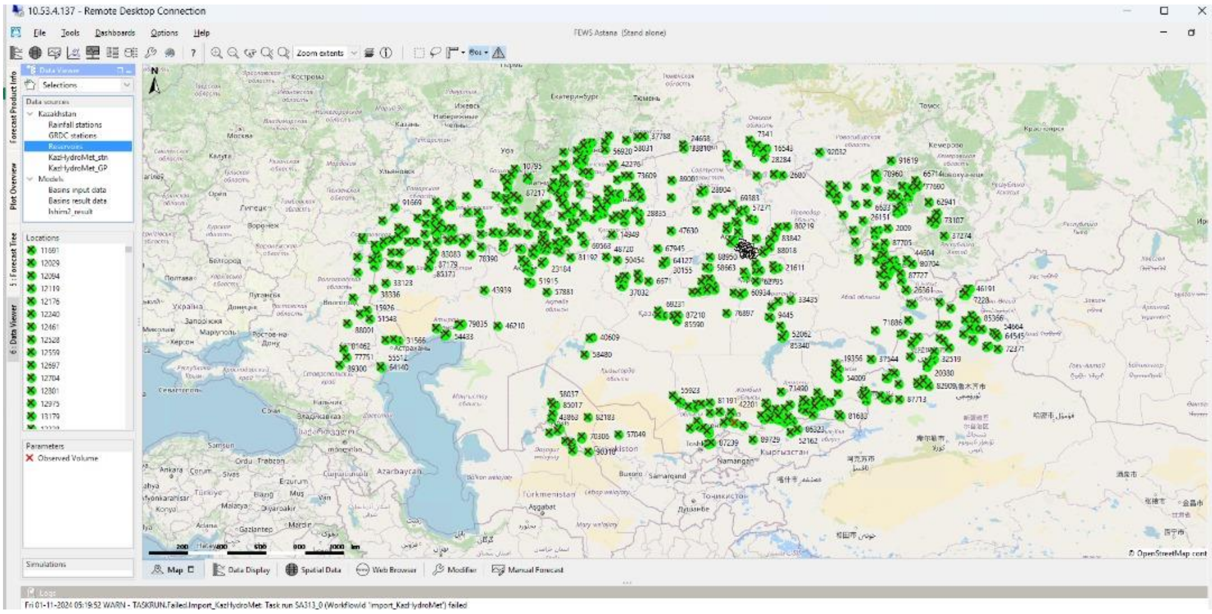

Figure 22: Inclusion of data from KazHydroMet's monitoring network into Delft-FEWS.

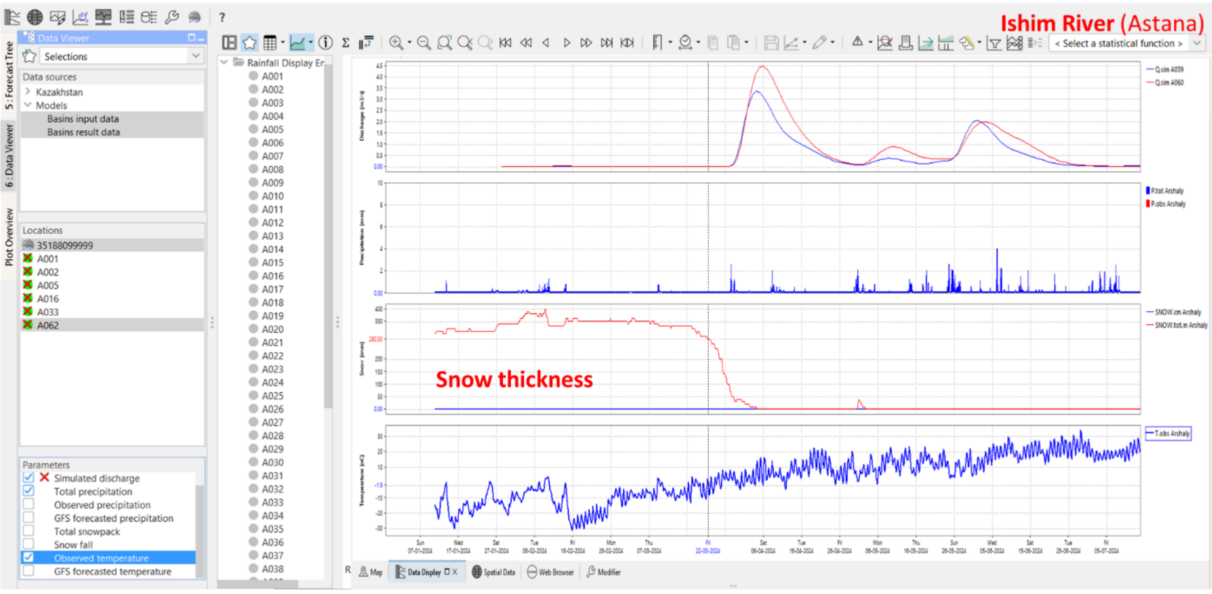

Figure 23: Ishim river model implementation in Delft-FEWS.

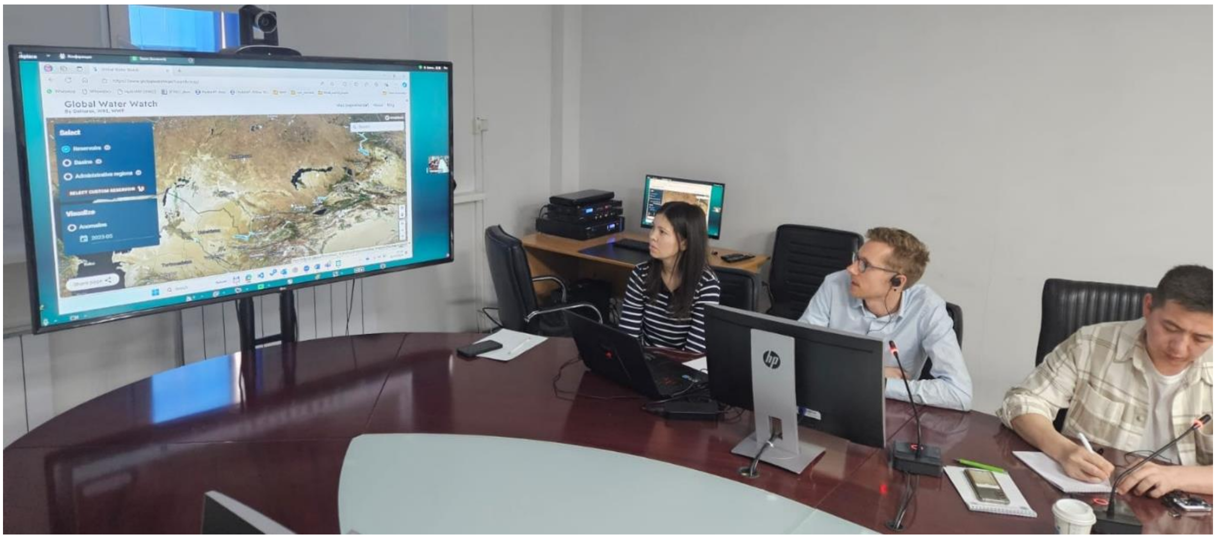

Figure 24: Demonstration of functioning of Global Water Watch and importing its data into Delft-FEWS.

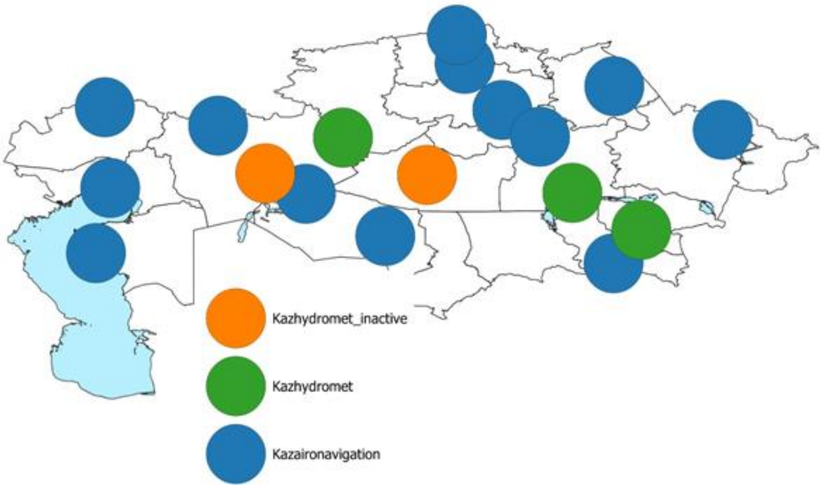

Figure 25: Radar station network in Kazakhstan.

3.4. Elaboration of Delft-FEWS roadmap

Annex V includes a roadmap for development of a national DELFT-FEWS system, detailing prioritized technical aspects and auxiliary activities to assure effective operation and autonomous use, such as:

1. Joining and streamlining existing hydro-meteorological data
2. Connect institutional roles, mandates, and responsibilities
3. Incorporating data from radar stations
4. Connecting to existing hydrological models
5. Using remote sensing data to fill gaps and expand monitoring
6. Development of information products and online publication of data
7. Further development of hydrological models
8. Definition of alert levels
9. Expansion of national monitoring network
10. Training and learn-by-doing

The route towards implementation of Delft-FEWS provides a structured demand-driven approach to enhance hydrological forecasting and disaster preparedness in Kazakhstan. By integrating diverse data sources, connecting institutional roles, and expanding monitoring capabilities, the system can significantly improve flood risk management in the country.

In a participatory exercise, a further inventory was made of the sequencing of actions, see Figure 26. While all listed options received multiple votes to be addressed in the short term, the most selected options were: “making use of radar monitoring network” (11 votes for 2024-25) and “using satellite data for monitoring water levels/reservoirs” (combined 18 votes for 2024-25).

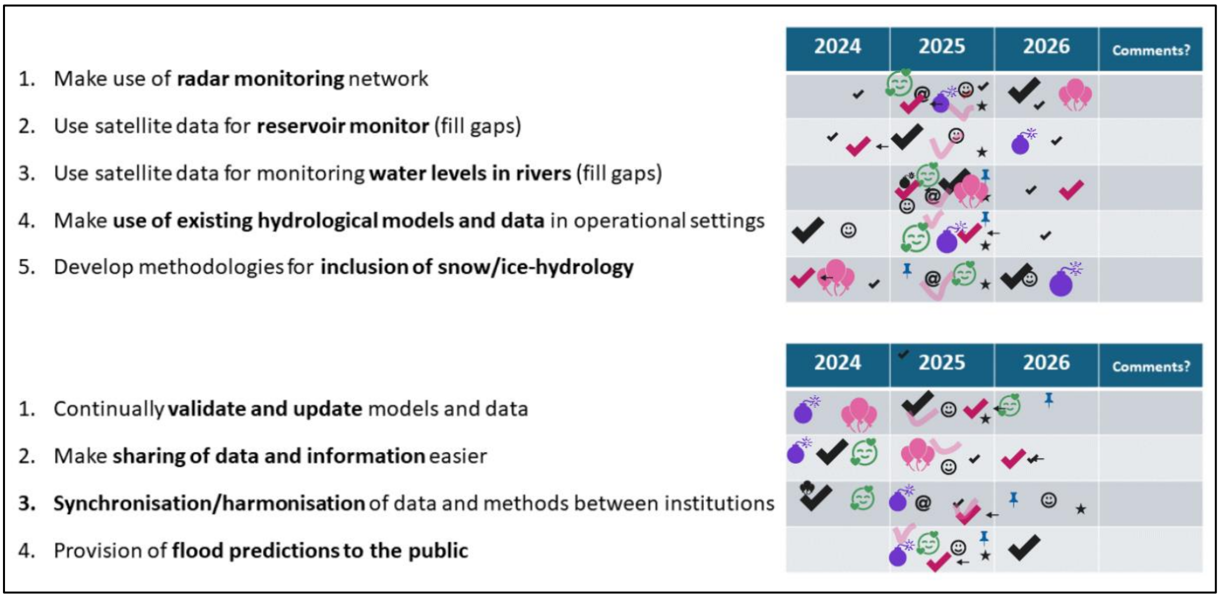

Figure 26: Participatory prioritizing of development action for Delft-FEWS implementation.

Based on the chosen priorities, two roadmaps were set up: one with a six-month time horizon (A) and another one with a three-year time horizon (B). In roadmap ‘A’, specific priority steps are included that build upon existing information and methods in Kazakhstan, and that can confidently be achieved within a short time frame. The proposed developments in ‘A’ will have immediate impact on operational flood forecasting and will offer Kazakh agencies the opportunity to learn-while-doing and open the way to further autonomous developments. Roadmap ‘B’ builds upon the steps of ‘A’ and includes further developments to achieve a nationwide forecasting system that integrates local and global data, makes use of innovations from Earth Observation, and offers actionable information products. Of great importance herein is the open sharing of hydro-meteorological data and remote sensing data, not only between institutions, but also for education and research institutions. During the collaboration weeks it showed that Kazakh authorities are opening up their data provision, as evident from some recent developments of several publicly-accessible information platforms (e.g. see Figure 7 and Figure 8 in Chapter 2). A key aspect of both roadmaps is the coordination between involved organizations and the objective of working towards autonomous use, autonomous maintenance, and autonomous further development of the forecasting system by Kazaks authorities. Details of both roadmaps are listed in Annex V.

3.5. Lessons-learned

Collaboration with and between involved institutions was of an open nature with a constructive attitude towards improving national practices in FRM. Participants shared challenges and specifically expressed needs for future developments. Also, there was strong dedication to move forward with the treated technologies and discussed topics. Between the two collaboration weeks already improvements in technical capabilities of participants were observed. Also, interest was expressed in developing capacity though follow-up projects and academic programmes/scholarships.

Kazakh authorities have unambiguously chosen a future in FRM that centers around development of a national flood forecasting system with Delft-FEWS. This technology is powerful and versatile, and can address all the specific technical and data-sharing needs that the institutions involved put forward. However, the Delft-FEWS system is also technically demanding, and requires dedicated involvement of institutions and their key technicians to make such a system effective and sustainable. To get a fully operational and robust forecasting system, more time and collaborative work is needed. By dividing the way forward in smaller phases or steps as part of a roadmap, the development tasks and responsibilities have been laid out in a realistic structured way.

There are many different stakeholders within Kazakhstan that benefit from a FEWS system. However, to have an effective and efficient system, good communication and collaboration is necessary between those stakeholders. Therefore, both users and configurators of the system should be involved in its development. Responsibilities and actions by stakeholders from the various involved Kazakh authorities should be well-coordinated. To assure a large enough base of users for sustainable future operation of Delft-FEWS in Kazakhstan, enough people need to be available to use and test the system, to get trainings and to install the operational system. Therefore, it is recommended that an interministerial working group is established around such developments, and that national educational and research institutes include in their curriculum aspects of flood forecasting methods and technologies. See Annex VIII for potential tasks and responsibilities of such a Working Group.

4. Collaboration week 3 (November - Aktobe)

Collaboration week 3 took place in Astana and the city of Aktobe (see map in Figure 27) during the dates 4 to 8 November 2024. This collaboration activity addressed the need for improved models of regions that have complex hydrological conditions, as expressed during Collaboration week 1.

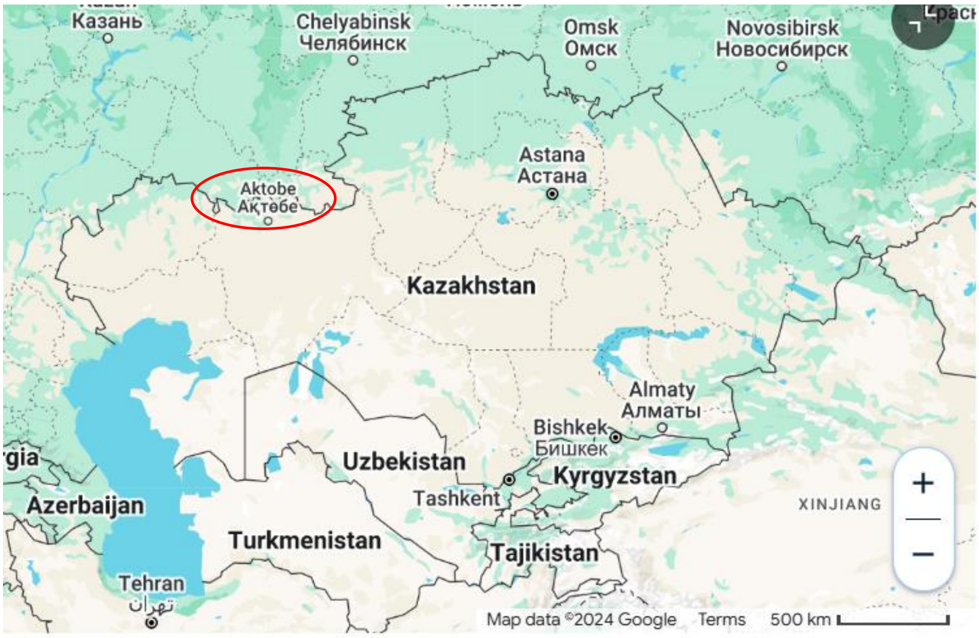

Figure 27: Map of Kazakhstan, indicating the city of Aktobe.

Figure 28 shows a group picture of participants in Aktobe during Collaboration week 3.

Figure 28: DRRS-Team and Kazakh participants during Collaboration week 3.

4.1. Approach, goals and deliverables

The third DRRS collaboration focused on flood modelling of the Aktobe region. The goals of the collaboration were:

1. To create appreciation of FRM practices at regional level (Aktobe) and to support local authorities in their objective to improve flood forecasting and associated FRM practices.
2. Have follow-up meetings with national authorities in Astana to formalize next collaborative steps in FRM.

Deliverable of this activity was a pilot hydrological model of the river basin network around Aktobe, which later could be implemented in a Delft-FEWS system.

4.2. Hydrological modelling

During the floods of April 2024, it was experienced that the actual flood magnitude in and around the city of Aktobe was much higher than what was anticipated in the preceding days. While the flood impacts did not grow to overwhelming proportions, damage occurred, and it was still a serious warning to local authorities that for the future better information provision and modelling capacity is needed. The main reason mentioned for the underestimated flood magnitude was that it appeared difficult to estimate the runoff from snowmelt in the region. Also, the existence of multiple reservoirs, some actively managed and some not, in combination with the joining of multiple river basins near the city of Aktobe, made the water balance difficult to assess and to anticipate on.

The collaboration activity in Aktobe centered around development of a hydrological model that connects the water storages and movements in the surrounding river basins and reservoirs. Such an activity would highlight the need for additional monitoring input and could serve as a component in a flood forecasting system (such as Delft-FEWS). The modelling software used in the training was of type WFLOW[16], which is free of charge and open source. Figure 29 shows the schematical lay-out of the model (left image) and output results from running the model (right image). In the training, various essential model components were added to the model step-by-step (river network, catchment areas, reservoirs, hydro-stations) and consecutive model refinements were shown to improve the accuracy of the output.

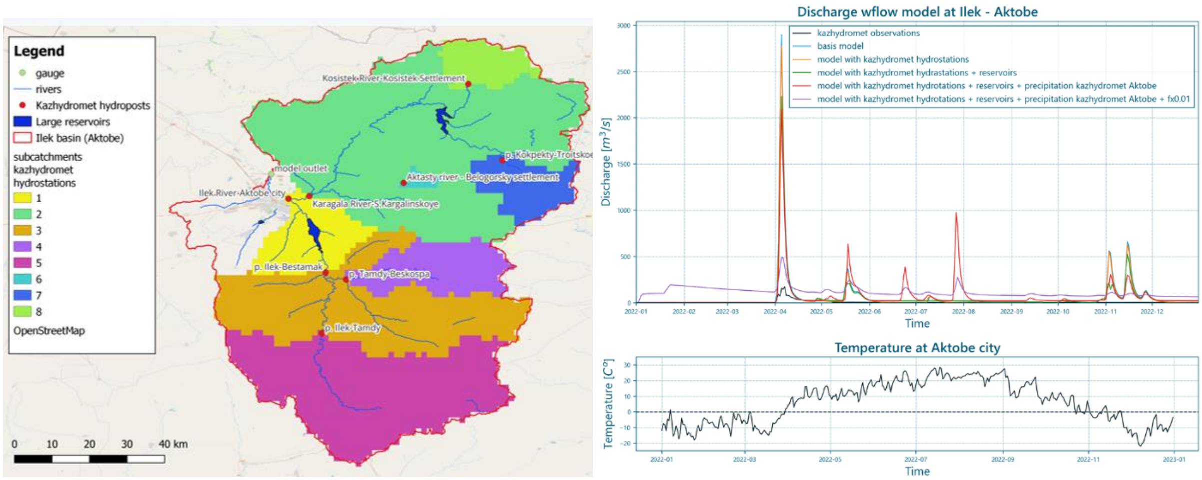

Figure 29: The developed WFLOW hydrological model for the river basins that connect at Aktobe city. Left: model river network catchment, hydro stations and reservoirs. Right: output validation after various modelling improvement steps.

Part of the model's development was to use input from local technicians on hydrological functioning of reservoirs during normal and extreme hydrological conditions. For example, during the floods of April 2024, reservoir operations primarily aimed at holding back water and only release waters if otherwise the reservoir capacities would be exceeded. These operation rules were implemented and

[16] https://www.deltares.nl/en/software-and-data/products/wflow-catchment-hydrology

tested in the model. With the model now alternative operation rules can also be tested that would minimize downstream flood peaks, while still staying within the boundaries of maximum reservoir storage volumes.

To get a better understanding of appropriate model settings, a one-day site visit was done around the city, see Figure 30 and Annex VII. The site visit served to better link characteristics from reality to its model representations. Visited sites included two reservoirs, one of which is actively regulated and one of which has a fixed (passive) overflow weir. Also, the junction of river branches near downtown Aktobe was visited to observe conditions where in April 2024 sudden flood waves from various river branches had to be accommodated.

Figure 30: Impressions from the field visit. Left: the largest regulated dam just upstream of Aktobe city. Right: bridge renovations to create more space for extreme river flows.

Based on the observations from the site visits, the next day discussions were held on river engineering concepts to reduce flood risk (such as creating 'Room for the River'), and on the possibilities and (data-)requirements for using hydrological modelling in flood forecasting.

4.3. KazHydroMet visit in Aktobe

On November 7 the premises of KazHydroMet in Aktobe were visited (Figure 31). The facilities were in very good state, with plenty of office space, appropriate IT hardware and good internet connection. During the discussions it was however shared that the results of the training from previous days would be difficult to absorb into the everyday operations of the organization. While all regional offices of KazHydroMet have been tasked to expand their services with forecasting activities, there is too little staff available to take on additional tasks, and among the existing staff none are readily equipped to work with the new technologies. Closer collaboration and coordination with national KazHydroMet office and joint longer-term dedicated capacity building activities are needed.

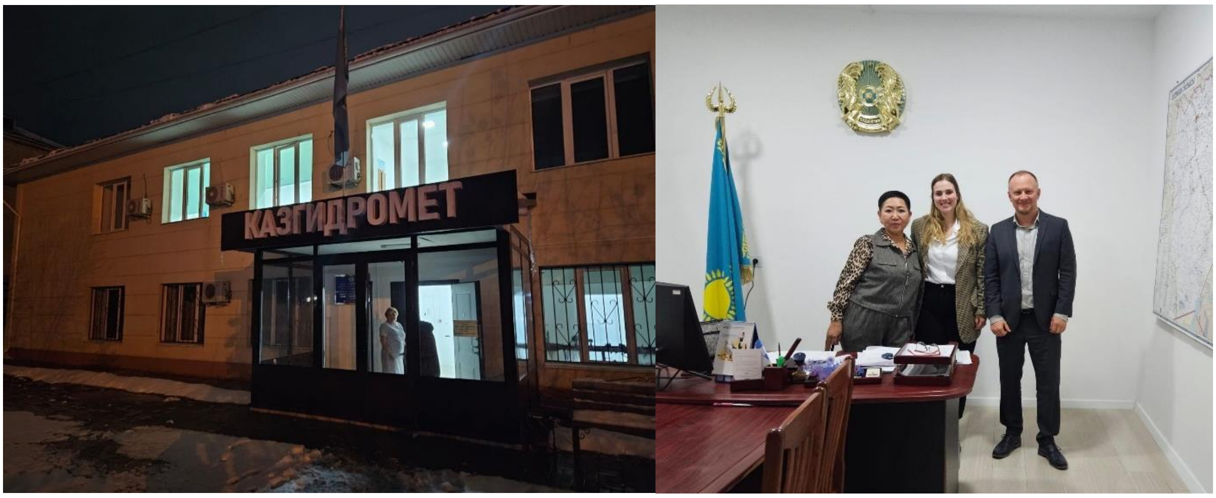

Figure 31: Visit to the premises of KazHydroMet in Aktobe (left), including meeting with regional director (right).

4.4. Gharysh Sapary visit in Astana

On November 5, the DRRS team visited space agency Gharysh Sapary in Astana to discuss their ambitions in flood modelling (Figure 32). The specific request was to advise on the development of nationwide flood maps, preferably linked to forecasted or real-time hydrological conditions. Possible linkages to the FastFlood tool (see Collaboration week 1) were discussed for rapid assessment possibilities covering large spatial areas.

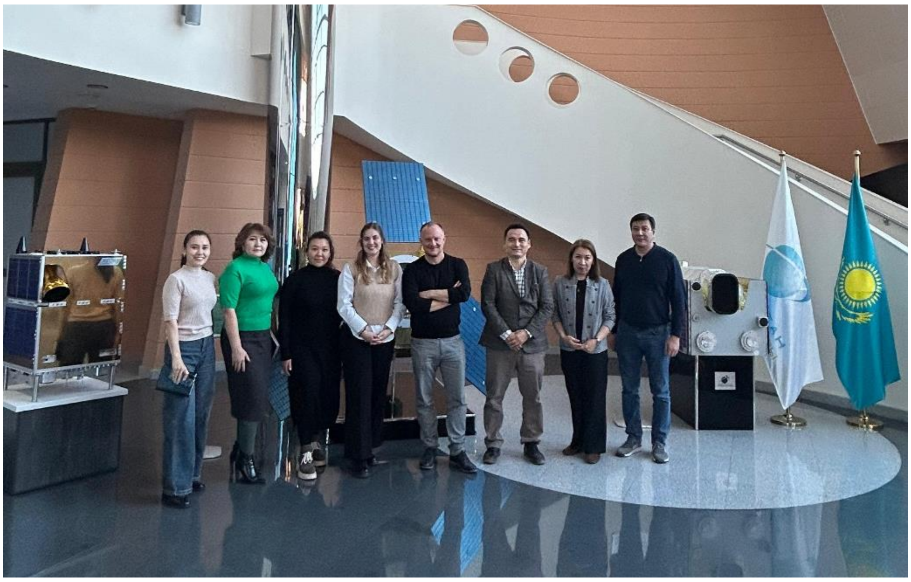

Figure 32: Meeting at Gharysh Sapary.

4.5. Debriefing at Ministry of Water Resources and Irrigation

Figure 33: Meeting at Ministry of Water Resources & Irrigation.

On November 8, a debriefing meeting was held at the Ministry of Water Resources & Irrigation in Astana, in presence of its vice minister. Also, a member of the board from KazHydroMet was present. During the meeting, impressions were shared on this year's collaboration activities, which had started in April and now came to completion in November with the training on hydrological modelling in Aktobe. Specific talking points were the mutual satisfaction with regard to relationships, insights and technical results that were achieved. The ministry also expressed appreciation for the recommendations from the DRRS Team and underlined dedication to assure collaborative follow-up. It was requested to DRRS that concrete propositions are made for development of methods and technologies in FRM, with particular focus on the implementation of Delft-FEWS.

Slides from the meeting are included in Annex VII.

5. Conclusions, recommendations, and next steps *(RU translation is available on a separate document)*

This chapter summarizes the main conclusions from the collaboration activities between Kazakh agencies and the DRRS team. Key points from this Chapter were also included in the debriefing meetings held on 11 September and 18 November 2024 (see Annex VII).

5.1. Conclusions

Kazakh authorities have shown a high degree of openness and ambition to continue collaboration on diverse aspects of Flood Risk Management. During the collaboration weeks, the focus was primarily on information technologies in flood risk management, but also aspects of the regional climate, institutional cooperation and capacity building were addressed. Pressing needs for technological improvement are in hydrological modelling, operationalization of Flood Forecasting technologies and improved public dissemination. The Kazakh authorities have chosen Delft-FEWS as preferred option for this development and requested propositions to make it work. Also, it was recognized that nation-wide flood hazard and risk maps are needed. The Gharysh Sapary (space agency) has expressed interest in seeking collaboration on this matter.

Furthermore, during the various discussions with the Ministry of water Resources and Irrigation, it became evident that willingness to collaborate goes beyond the theme of information technologies in flood risk management. There is interest in improved land use planning to optimize water use, to reduce flood and drought risks, and there is interest in improved engineering studies for improved water regulation and related infrastructures.

An underlying challenge to all the desired developments in FRM is the capacity of the existing workforce at involved institutions, as well as the efficiency of collaboration between these. Dedicated capacity building activities are needed, covering all aspects of FRM, involving national and regional agencies, and research and educational institutes.

Seen the increasing need for cooperation between the institutions, (high-level) coordination of FRM activities is needed.

5.2. Recommendations

Based on the discussions, the joint technical activities and participatory roadmap development, the following key follow-up actions are recommended to enhance flood risk management in Kazakhstan:

1. Highest Priority: Improved flood forecasting by operationalizing Delft-FEWS

The action of highest priority is to operationalize the Delft Flood Early Warning System (Delft-FEWS), for which the Kazakh authority would like to show first results already in the first half of 2025. This initiative combines technical, capacity, and institutional needs to ensure effective flood management. A proposed collaborative effort over the next three years should focus on the operational implementation of Delft-FEWS in Kazakhstan, with technical support to ensure development of essential technical components (data processing, modelling, etc.) and effective embedding in local procedures and autonomous use at involved institutions. It is advised to start such a multi-year endeavor with a detailed plan for the first six months, and after that define next steps based on achievements and lessons-learned. By gradually building upon existing successful methods that are used within Kazakhstan, trained technicians can step-by-step embrace innovations and work towards new flood forecasting and water regulation services.

2. High Priority: Hazards and Risk Mapping

The second priority is to conduct comprehensive hazards and risk mapping in Kazakhstan. This action will also address technical, capacity, and institutional needs. The mapping process identifies hazard zones and potential impacts, facilitating adaptation and sustainable planning efforts, including infrastructure development, sustainable land use planning and (river) engineering works (nature-based solutions, room for the river). Additionally, emergency actions such as evacuation planning can be enhanced through this initiative. Training programs could complement the activity to ensure continual updating of products and effective application in practice.

3. Institutional & Capacity Development

The third priority area involves strengthening institutional and technical capacity. This encompasses human resource development and an increase of inter-ministerial coordination, harmonization, and priority setting. Given the limited capacity available and the more demanding service-requests from the sectors, to optimize the use of the available capacity and keep track of new developments, this will become increasingly important. Therefore, a wider base of skilled professionals is needed, at national level but also to support the responsibilities and ambitions of regional agencies.

To support capacity development, it is advised to map the available and desired human resources by comparing the current situation with future sector plans in terms of size, responsibilities, and tasks of the workforce.

For sustainably building required technical expertise, knowledge sharing and an increased cooperation with national and international professional specialists and academia is required. Besides collaborative technical projects also opportunities for higher education—such as curricula developments at national institutions, as well as partnerships and/or internships under the "Bolashak" scholarship program—can be explored. These initiatives aim to sustainably cultivate a broad and skilled workforce capable of addressing essential aspects of water and disaster management. It is advised that the Ministry of Water Resources and Irrigation connects with the Ministry of Education and the Bolashak office to request a dedicated focus area on Water Management in the programme.

4. Institutional coordination and harmonization

To achieve existing and future development goals in flood risk management also more understanding, coordination and harmonization is needed between the experts, policy makers, water managers, risk managers, and regulators. Effective collaboration on the development of a national Delft-FEWS forecasting and system will be a crucial test for success on this matter. A high level interministerial platform on water risk reduction could function as a communication platform between information producers and users, but also as platform for coordination, harmonization and prioritization of developments. The Water Risk Reduction Working Group should set clear tasks, obligations, rights and provisions as presented under lessons learned. As land use is recognized as a critical point in flood risk reduction, harmonization and use of intersectoral tools may be discussed on this level. This will also include providing advice and conducting exercises on Integrated Flood Risk Management (FRM).

By prioritizing these actions, Kazakhstan can significantly enhance its flood risk management capabilities.

5.3. Next steps

Improved Flood Forecasting

Combine and expand data sources while incorporating physics-based modeling tools. The roadmap for Delft-FEWS should focus on integrating existing methods and tools into a unified system. Develop components to expand the monitoring network, including Global Water Watch (reservoir monitoring), radar (rainfall) monitoring, global datasets for climate observations.

For the first six months of Delft-FEWS development, a detailed, demand-driven plan will be provided to Kazakh authorities.

Actions:
- Step-by-step approach for Delft-FEWS implementation
- Support for rapid flood extents modelling (e.g., Fastflood implementation)
- Water Watch support

Hazard and Risk Mapping

Flood maps are essential as a baseline for risk-reducing spatial planning and for creating flood emergency plans. A nationwide flood risk assessment will help find vulnerable assets and provide a foundation for future infrastructure and land use development. In addition to protecting assets, strategic land-use plans to reduce flood and drought risks can be made.

In the absence of real-time flood extent forecasting, flood maps can be used alongside hydrological forecasts (river discharge data) to assist decision-making during disasters or in advance of them.

Actions:
- Expand hydrological modeling for river basins across Kazakhstan
- Develop national flood hazard and risk maps

Capacity building

Initiate programs and set up partnerships with research institutes to build a strong foundation of thematic experts who can support local and national agencies in water management development. Additionally, develop curricula focused on water and disaster management.

For academic collaboration, opportunities could be explored to define a specialized track within the Bolashak Scholarship Program, offering talented students the chance to pursue advanced studies in engineering and water management at (Dutch) institutions. Consider the possibility of guest positions for international experts at Kazakh universities. These experts could lead workshops, seminars, contribute to collaborative research, and assist in curriculum development. One institution that could immediately benefit is the newly established Taraz Water University, with experts to help develop its curriculum and enhance its programs.

Local agencies, such as Kazhydromet in Aktobe, have good facilities but lack the necessary equipment and staff to upgrade their forecasting capabilities. Specialized training is needed for IT and hydro-meteorological experts.

Actions:
- Map capacity needs at key institutions
- Provide training and support to local agencies

Institutional development

From the point of view of Flood Risk Management, but also to the related drought risk management, there is an increasing need for collaboration, harmonization and synchronization between institutions and policies, priority settings for future action. This could be arranged in the form of a High-level Water Risk Reduction Working group under the Prime Minister. See Annex VIII for potential tasks and responsibilities of such a Working Group.

Actions:
- Establish a Water Risk reduction Working Group to harmonize policies, strategies, methodologies, fill the gaps in responsibilities between institutions, facilitate information exchange, and priorities future innovations.
- Establish or strengthen partnerships between institutes
- Open up data on remote sensing and hydro-meteorology to optimize the national capacity on water risk reduction

ANNEXES

Annex I: Official Request / Action Plan / Note Verbal from scoping visit (April 2024)

1. Official request

ҚАЗАҚСТАН РЕСПУБЛИКАСЫ
СУ РЕСУРСТАРЫ
ЖӘНЕ ИРРИГАЦИЯ
МИНИСТРЛІГІ

МИНИСТЕРСТВО
ВОДНЫХ РЕСУРСОВ И
ИРРИГАЦИИ
РЕСПУБЛИКИ КАЗАХСТАН

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№ 01-01-09/828
10.04.2024

To Dutch Disaster Risk
Reduction and Surge
Support Team
Mrs. Sandra Cats

Dear Mrs. Sandra Cats!

The Ministry of Water Resources and Irrigation of the Republic of Kazakhstan presents its compliments and reaching out to you during a time of critical need. A state of emergency has been declared in ten regions of north-western Kazakhstan due to severe flooding that has disrupted our citizen's way of life.

Given the Netherlands' renowned expertise and progressive approaches in water management and flood mitigation, it is with great respect and urgency that we seek your collaboration. We are eager to learn from your experiences and to explore potential avenues for cooperation that could aid in our immediate response efforts and contribute to our long-term resilience strategies.

We are particularly interested in understanding the methods and technologies you employ in flood prevention, emergency response, and post-disaster recovery.

Please let us know your availability for a preliminary discussion at your earliest convenience. To facilitate a constructive dialogue and further meeting arrangement, we suggest that all technical inquiries and preliminary discussions be directed to [redacted]

We look forward to the opportunity to work closely with the Dutch Disaster Risk Reduction and Surge Team and thank you in advance for considering our request for support and cooperation.

With best regards,

Acting Minister of Water Resources and Irrigation **B. Bekniyaz**

2. Action plan

See attached document '**Annex Ib_DRRS KAZNL Action Plan_02052024.pdf**'.

3. Note Verbal

See attached document '**Annex Ic_NoteVerbal_24042024.pdf**'.

Annex II: Terms of Reference for Collaboration Weeks

See attached documents:

'**Annex IIa_20240801 ToR DRRS Kazakhstan 2024_TL**'.

Annex III: Concept note and agenda of Collaboration Weeks

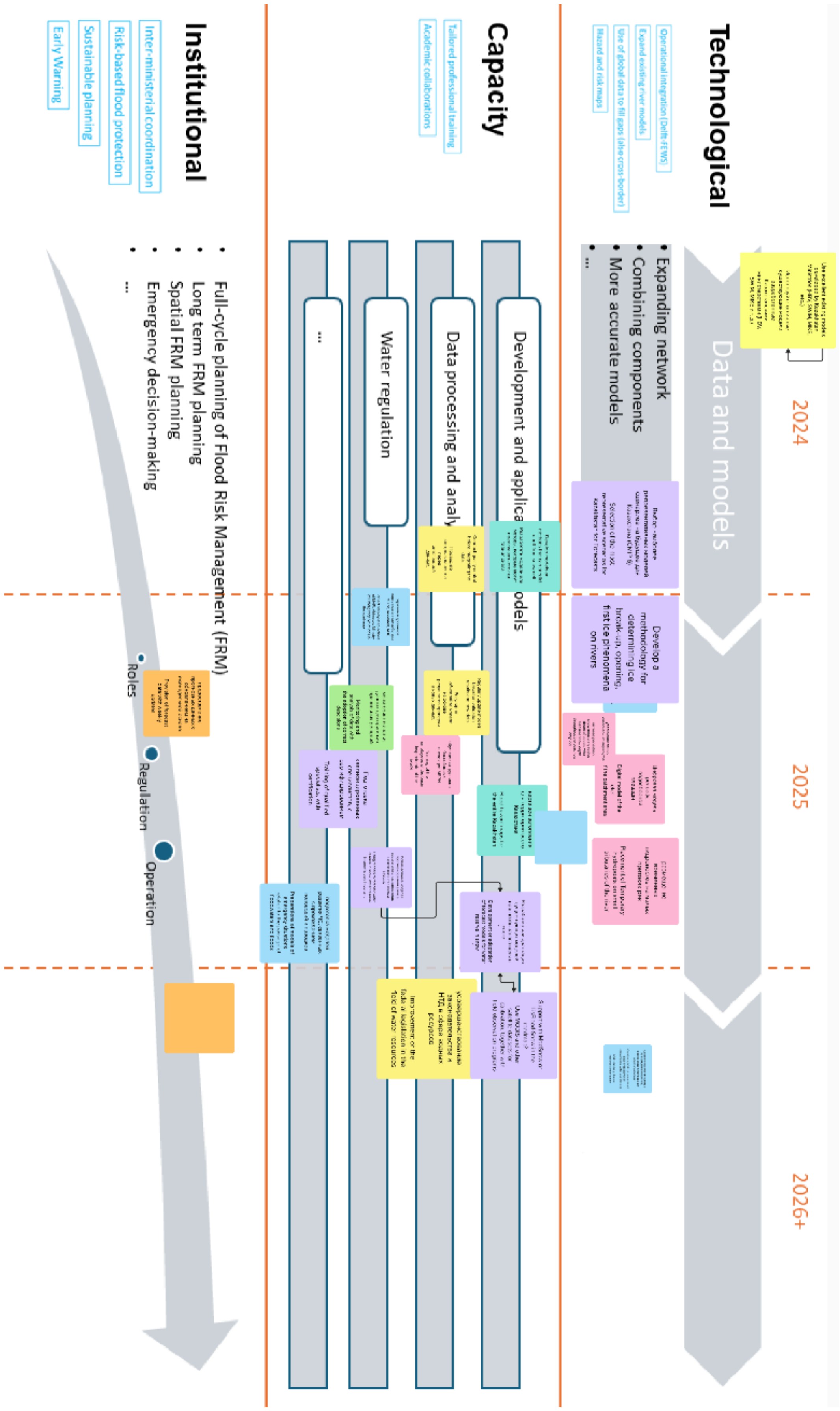
See documents:

‘**Annex IIIa_Concept note 1st Kaz-NL collaboration week - August 2024.pdf**’

‘**Annex IIIb_Concept note 2nd Kaz-NL collaboration week - October 2024.pdf**’

‘**Annex IIIc_Concept note 3rd Kaz-NL collaboration week - November 2024.pdf**’.

Annex IV: Preliminary Roadmap on FRM



Annex V: Delft-FEWS roadmap

The draft roadmap towards autonomous use of Delft-FEWS provides a structured approach to enhance hydrological forecasting and disaster preparedness in Kazakhstan. By integrating diverse data sources, connecting institutional roles, and expanding monitoring capabilities, the system can significantly improve flood risk management and resilience in affected communities.

Below, two roadmaps are outlined: (A) with a six-month time horizon. and (B) with a three-year time horizon. In roadmap 'A', specific steps are proposed that build upon existing information and methods, and that can confidently be achieved within a short time frame. These proposed developments will have immediate impact on operational flood forecasting and offer Kazakh agencies the opportunity to learn-while-doing and potentially open the way to further autonomous developments. Roadmap 'B' builds upon the steps of 'A'. Here, further developments are outlined to eventually achieve a nationwide forecasting system that integrates local and global data, makes use of innovations from Earth Observation, and offers actionable information products.

A key aspect of both roadmaps is the objective of working towards autonomous use, autonomous maintenance and autonomous further development of the forecasting system by Kazaks authorities.

A. DELFT-FEWS roadmap with six-month time horizon

1. Development of forecasts for Ishim River (months 1-4)

- Creating the technical and functional requirements for this phase
- Implementing an operational server-based system
    - Installation of an operational network implementation on a server in Kazakhstan.
    - Training of technical maintainers of the network implementations.
- Finalizing the configuration of the KazHydroMet-API
    - Finalizing and detailing the configuration of the KazHydroMet-API, as started during the training in October.
    - Implementing an easily accessible weather forecast product (if available KazHydroMet or otherwise ICON, ECMWF or similar)
- Finalizing the model implementation of Ishim river
    - Finalizing and detailing the configuration of the Talsim model, as started during the training in October.
- Learn-by-doing interactions of all previous steps

2. Expansion of data sources and information products (months 1-4)

- Creating the technical and functional requirements for this phase
- Implementing connection to KazHydroMet Radar systems
    - Operationalizing radar rainfall for the 3 radars of KazHydroMet, as started during the training in October.
- Connecting to space-based observations
    - Implementing data from global snow/ice layer observations.
    - Implementing data from reservoir observation (surface area detections).
- Implementing alert thresholds
    - Implementing thresholds and warnings based on those as currently used at KazHydroMet and the Emergency department
- Visualizations
    - Implementing information visualizations of the forecasts and historic data.
- Learn-by-doing interactions of all previous steps

3. Sustaining autonomous use and further development of DELFT-FEWS (months 1-6)

- Test period by Kazakh users
- Intermittent user/developer training
- Comprehensive documentation of the system, including architecture for further developments.

B. DELFT-FEWS roadmap with three-year time horizon

In the 3-year horizon the ultimate goal is to achieve full autonomous use of a nationwide Delft FEWS system. A detailed time planning has to be coordinated with relevant agencies in Kazakhstan. Below, key components of the roadmap are listed.

1. Joining and Streamlining Existing Hydro-Meteorological Data

Joining and streamlining existing hydro-meteorological data is crucial. By conducting an inventory of available data and establishing a centralized database, stakeholders can ensure that information is consistently updated and easily accessible. This step will promote efficient data sharing and improve forecasting accuracy. Part of this activity was already included in the 6-month roadmap.

Action Steps:

- Conduct an inventory of existing hydro-meteorological data sources.
- Develop a centralized database to consolidate data from various agencies.
- Establish standard data formats and protocols for data sharing.
- Ensure regular updates and maintenance of the database.

2. Connect Institutional Roles and Responsibilities

Next, it is important to connect institutional roles and responsibilities. Identifying key stakeholders and clarifying their functions within the hydrological data network will stimulate effective collaboration. Regular communication among these entities will enhance coordination and enable a more cohesive approach to water resource management.

Action Steps:

- Identify key stakeholders and their roles in the hydrological data network.
- Create a governance framework that clarifies responsibilities and fosters collaboration.
- Schedule regular meetings to facilitate communication and address challenges.
- Develop a communication plan to disseminate information among stakeholders.

3. Incorporating Data from Radar Stations

Expansion of data from radar stations will further strengthen the system. By integrating radar data into Delft-FEWS, decision-makers can obtain real-time information critical for flood forecasting. Training personnel on interpreting this data will maximize its utility in emergency situations. Part of this activity was already included in the 6-month roadmap.

Action Steps:

- Identify existing radar stations and their coverage areas.
- Develop methods for integrating radar data into the Delft-FEWS platform.
- Train personnel on interpreting and utilizing radar data for flood forecasting.
- Establish protocols for real-time data sharing from radar stations.

4. Connecting to Existing Hydrological Models

Linking additional existing hydrological models to Delft-FEWS. This connection will allow for better predictions by standardizing data formats and ensuring that model outputs are accurate and reliable. Part of this activity was already included in the 6-month roadmap.

Action Steps:

- Inventory current hydrological models in use within institutions.
- Create integration pathways for linking these models with Delft-FEWS.
- Standardize input and output formats for seamless data exchange.
- Validate model outputs through case studies to ensure accuracy.

5. Using Remote Sensing Data to Fill Gaps and Expand Monitoring

Using remote sensing data to fill monitoring gaps is another key aspect. By identifying relevant satellite data sources and developing algorithms for integration, Delft-FEWS can enhance its monitoring capabilities, filing of data gaps and leading to improved forecasting outcomes. A particular innovation of interest is the connection to space-based reservoir observations and remote snow/ice observations. Part of this activity was already included in the collaboration week 2, and of 6-month roadmap.

Action Steps:

- Identify satellite data sources relevant to hydrological monitoring (e.g., precipitation, land use).
- Develop algorithms for processing and integrating remote sensing data into the forecasting system.
- Train staff on remote sensing techniques and applications in hydrology.
- Establish a feedback loop to continuously assess the utility of remote sensing data.

6. Development of Information Products and Online Publication of Data

The development of information products and the online publication of data are also essential components. Creating user-friendly dashboards and tailored information for various audiences will ensure that critical data reaches the right stakeholders in a timely manner. This transparency will stimulate community awareness and preparedness. Part of this activity was demonstrated during Collaboration Week 1.

Action Steps:

- Design user-friendly dashboards and visualizations for stakeholders and the public.
- Create a website for online publication of real-time data and forecasts.
- Develop tailored information products for different audiences (e.g., policymakers, emergency responders).
- Implement a system for regular updates and user feedback on information products.

7. Further Development of Hydrological Models

Expanding the geographical scope of these models, and including snowmelt and ice processes, will provide a more comprehensive view of nationwide hydrological conditions.

Action Steps:

- Expand the geographical scope of existing models to cover new areas.
- Incorporate snowmelt and ice processes into modeling frameworks.
- Conduct validation studies to enhance model reliability.
- Engage with researchers and practitioners to gather insights on model improvements.

8. Definition of Alert Levels

Defining alert levels based on hydrological data is crucial for effective response planning. Collaborating with emergency services to review and align these levels with response protocols will ensure that communities are adequately informed and prepared for potential flooding events.

Action Steps:

- Develop criteria for defining alert levels based on hydrological data and historical trends.
- Collaborate with emergency services to align alert levels with response protocols.
- Implement a public awareness campaign to inform communities about alert levels and responses.
- Test the alert system through simulations and refine based on feedback.

9. Expansion of National Monitoring Network

Expanding the national monitoring network will provide comprehensive coverage and improve data accuracy. By assessing current monitoring locations and prioritizing areas for new stations, stakeholders can ensure that the system captures real-time data essential for effective forecasting.

Action Steps:

- Assess current monitoring network coverage and identify gaps.
- Prioritize locations for new monitoring stations based on risk assessment.
- Secure funding and partnerships for expanding the network.
- Ensure new stations are integrated into the Delft-FEWS for real-time data input.

Approximate timeline and milestones

- Phase 1 (Months 1-6): Data inventory, governance framework, radar station integration.
- Phase 2 (Months 7-12): Remote sensing integration, model connections, and alert level definitions.
- Phase 3 (Months 13-24): Information products development and national monitoring network expansion.
- Phase 4 (Months 19-24): Testing, validation, and stakeholder feedback to refine the system.
- Phase 5 (Months 24-36): Refining of system and moving towards full autonomous use in Kazakhstan.

Annex VI: Aktobe collaboration week material

See documents:

'**Annex VIa_DRRS_Aktobe_Fieldtrip_06112024.pdf**'

Annex VII: DRRS debriefing presentations

See documents:

'**Annex VIIa_DRRS_KAZ2024_Debrief_10092024.pdf**'

'**Annex VIIb_DRRS_KAZ2024_Debrief_18112024.pdf**'.

Annex VIII: Potential tasks for a high-level Water Hazard Working Group

These tasks can be combined with initiation of a high-level Water Hazard Working Group, having potential tasks and responsibilities as outlined below.

Tasks

- Intersectoral Information gathering – analysis
- Assessment of Risk Prevention
- Proposing Priorities
- Filling capacity gaps between institutions
- Future scenario development – harmonization / synchronization policies
- Bringing policy and tech capacity together
- Advising on investments: at source or place of impact
- Assessing climate change impact
- Harmonizing modelling request
- Coordination of research – further opening up data access by law
- Capacity building

Responsibilities

- Coordination inter-ministerial approach water risk prevention
- Updating the institutions with technical development and Priority setting
- Management of Common Knowledge Base, also accessibility for third parties like research and education
- Monthly and yearly public reporting on water related risks

Provisions

- Working Budget
- Freedom of publicity

Rights

- Information collection right
- Authorized to give (un)requested recommendations