TASHKENT MAY 2011

Towards the 6th World Water Forum —
Cooperative Actions for Water Security

International Conference

12-13 May 2011
Tashkent, Uzbekistan

Risk Management and Water Security

Concept Note on Thematic Priority

REGIONAL PROCESS COMMISSION:
CENTRAL ASIA CROSS-CONTINENTAL PROCESS

Towards the 6th World Water Forum – Cooperative Actions for Water Security

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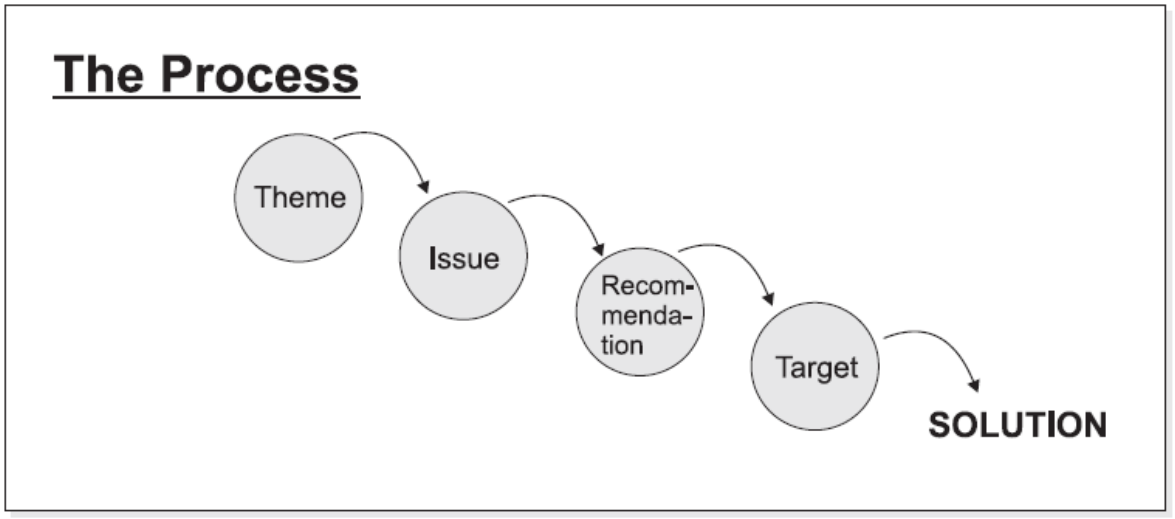
Risk Management and Water Security

Concept Note

This Concept Note was prepared within the framework of the Process development framework "From targets to solutions" (Fig. 1) adopted by WWC and the International Forum Committee. The Concept Note sets up successive steps for development of the proposals on solution of urgent water problems towards the 6th World Water Forum.



Schematic representation of the process involved in the development of "solutions" for the World Water Forum 6 (redrawn from the presentation of Prof. B. Braga at the Stockholm world water week, 8 September, 2010).

Fig. 1

Water security sites in Central Asia

The Central Asian countries are situated in a single bound environmental space. Mountains covered with eternal snows are contrasted with adjacent vast desert plains in this region.

Water resources originate from renewable surface water, groundwater, and return water. The modern hydrographic network is represented by the rivers of Amudarya and Syrdarya basins and connected lakes, as well as by the multiple irrigation and drainage systems.

The history of artificial irrigation in the region counts centuries since the ancient times.

With economic development, large hydraulic structures and irrigation systems, including many in- and off-stream reservoirs for multiple uses were constructed in the region.

Hydraulic structures with their very important functions have a great effect on economic development and social sphere, as well as on environmental sustainability. Therefore their safety and reliable operation become especially topical. Moreover, safety of these structures is important for safe functioning of industries and other facilities and, chiefly, for safe living of the population in the affected zone.

Hydraulic structures form a part of a national infrastructure. Therefore, social consequences and damage to property due to failure or destruction of these structures, mainly in result of break wave effect, are comparable with natural disasters. The probability of large hydraulic structure accidents increases as the lifetime runs out.

The Central Asian countries have a well-developed water infrastructure including a lot of interstate hydraulic structures. There are large hydraulic projects, such as Nurek HPS on the Vaksh river in Tajikistan, Toktogul HPS on the Naryn river in Kyrgyzstan, Charvak HPS on the Chirchik river, Kairakkum and Shardara HPSs on the Syrdarya river; large waterworks: Kzylorda, Kazalinsk, Takhiatash, Karshi; main irrigation canals: Big Hissar, Big Fergana, Big Andizhan, Yujnogolodnostepskiy, Tashsaka, Vaksh, Kzylorda, and Karakum canals; and, modern pump irrigation systems, such as Amu-Bukhara, Karshi, Sherabad, etc. The large-scale hydraulic engineering construction may both change significantly the ecosystem conditions and pose a potential risk of large-scale accidents and anthropogenic emergencies due to failures and malfunctions.

Besides, Central Asia refers to the category of earthquake-prone zones. This raises a risk of accidents at large hydraulic structures. Potential accidents at these structures, especially those located in the upstream of transboundary rivers, caused by strong earthquakes may provoke artificial tsunami and have irrecoverable consequences.

Characteristics of large reservoirs

River	Reservoir	Storage capacity, Mm^3	
		gross capacity	dead zone
Chirchik	Charvak, Uzbekistan	2010	430
Naryn	Toktogul, Kyrgyzstan	19500	5500
Karadarya	Andizhan, Uzbekistan	1900	150
Syrdarya	Kairakkum, Tajikistan	3400	917
Syrdarya	Shardara, Kazakhstan	5200	520
Vaksh	Nurek, Tajikistan	10500	5960
Amudarya	Tuyamuyun, Uzbekistan	6510	2268

Growing emergencies in the world

Despite the growth of technical equipment, the technological improvement and the accumulated experience in hydraulic construction, unforeseen situations have become more widespread recently.

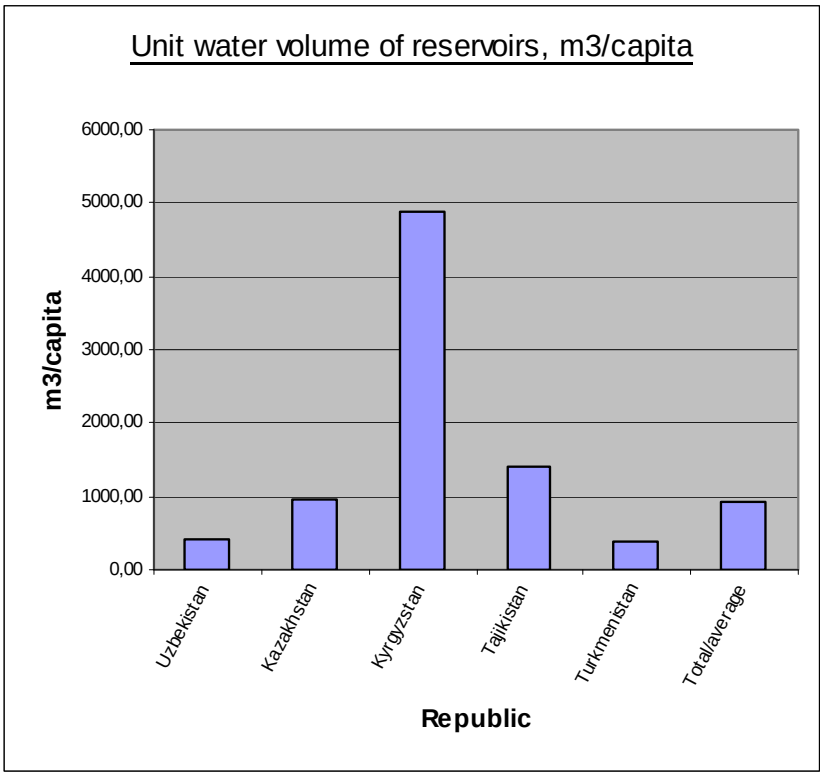
The hydraulic construction records show numerous accidents and, moreover, some of them have caused social losses and damages.

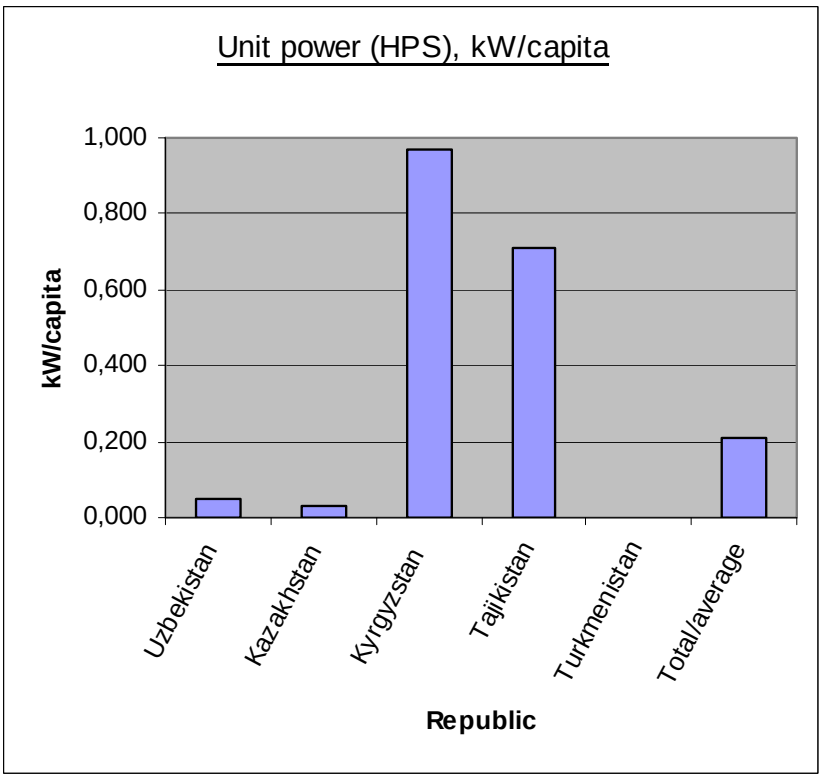
Examples of critical dam emergencies

Dam, country	Type/ height (m)	Year of emergency	Main causes	Number of victims
Tirlyansk (Russia, Bashkortostan)		1994 7 August	Break of dam	29 deaths 786 people left homeless
Wittenberg, Elbe river (Germany)	Dike dams	2002 18 August	Destruction of 7 dike dams	85 dwellings ruined 45 deaths
Pasni town (Pakistan)	Hydroelectric dam, 150m	2005 11 February	Break of dam	Several villages submerged. 135 deaths
HPS «Kyadat» on Chu river (China)		2007 5 October	Break of dam at HPS under construction	5000 dwellings ruined 35 deaths
Sayan-Shushensk HPS (Russia)		2009	Break of dam, flooding of turbine room	74 deaths
Kyzylagash (Kazakhstan)	42 Mm^3	2010 12 March	Break of dam	257 dwellings ruined 44 deaths
Hungary		2010 4 October	Break of dike dam as a result of a burst	
Vitke (Poland)		2010 8 August	Destruction of dam	
Obsu town (Sweden)		2010 11 November	Destruction of dam	

The case of a small dam of Kyzylagash (Kazakhstan), which was broken last year and caused a lot of deaths and damage to property calls for more attention to monitoring of conditions of any hydraulic structure. Huge losses caused by natural floods in West Kazakhstan area in April 2011 are well known. Moreover, one should note here the risk of dam destruction due to non-coordinated river regimes. For example, this caused more than US$ 17 millions of damage in the Syrdarya delta in 2004-2005. As a result, the Central Asian countries has become concerned seriously about the deterioration of reliability and safety of large hydraulic structures. These

structures are mainly located on transboundary watercourses (more than 300 structures), supply water for about 90% of agricultural production, 40% of energy generation, and, as a whole, ensure sustainable functioning of other economic sectors and, chiefly, safety of about 50% of population in the region.





The current state of large hydraulic structures

Large dams are operated during more than 40-50 years and, consequently, became silted and obsolete. This results in deterioration of their reliability and technical capabilities.

The Government monitors safety of hydraulic structures through special legislation and the executive government bodies authorized to supervise execution of legislation by owners or operators of hydraulic structures.

The forms of state monitoring are various in different countries and depend on specific civil legislation of given country, its administrative division, and the structure of executive authorities, as well as on the earlier formed traditions and institutes for provision of safety of hydraulic structures.

The criteria for setting a class of hazard for a hydraulic structure are determined in the legislation and, typically, include:

- height of water-retaining structures;
- capacity of reservoir;
- risk of accidents at hydraulic structure (likely quantity of victims, damage to property of third parties, environmental damage);
- contribution of hydraulic structure to regulation of flow regime in transboundary rivers or to water supply of neighboring countries (for example, beneficial location as adopted in the Austrian legislation).

The scope of legislation of safety of hydraulic structures usually spreads to all stages of their life cycle: from design through construction to conservation and abandonment.

I. Operation of reservoirs

a) silting of reservoir bowl and obstruction of intakes. This is observed in most in-stream reservoirs. Such conditions cause the loss of useful capacity and flow capacities of structures, and, consequently, increase the risk of spillover and destruction of dam.

b) risk of slope collapse and slides on the walls of reservoirs that are located mainly in mountain areas. This may lead to a dam break wave.

c) high seepage at the base of walls. This has a negative effect on stability of dam.

d) mechanical and chemical piping of soil at the base and in the body of a dam.

e) shrinkage of crest exceeding the design values. The main cause of such shrinkage is the rise of seepage line on the body of a dam.

f) risk of spillover due to a combination of a number of external forces (wind, earthquake, filled bowl).

g) destruction of concrete casing of the upstream face.

h) lack of normal drainage of seepage water at dams. Construction and re-construction of drainage systems is needed for these dams.

i) deterioration of cement-grout curtain and case hardening at dams.

j) no seam sealing and presence of cracks on concrete frames of structures.

k) unsatisfactory conditions requiring replacement of lift mechanisms and hydraulic drives that have shorter serviceability period than structures.

l) erosion of the tail-water.

m) lack of automated gate control systems, poor technical characteristics of communication system, insufficiently reliable power supply and early warning systems in case of emergencies.

n) Insufficient equipping of storage dams with measuring devices necessary for regular field observations over the state of structures. Only a part of measuring devices is operational in many reservoirs, while the rest is out of order. As a result, monitoring over the state of these structures in not possible.

II. Operation of pump stations is complicated since they have been operated already over a long period of time and, consequently, are damaged and degraded.

Among the damages are siltation of intakes, wear of impeller, pressure pipes and bulkhead gates, seepage in underground part, water logging of area, deterioration of electrical and switching equipment, breakdown of some electric motors, increase of vibrations, overheating of motors and their coils, non-operation or lack of measuring devices.

III. Operation of main canals and hydroschemes is difficult since mechanical and electrical equipment has been operated already over a long period of time and concrete frames have become deformed and deteriorated.

Among the damages are deformation of siphons and aqueducts, silting of canals, upstream and downstream pools, erosion of channels and slopes, obsoleteness of electrical and mechanical equipment of structures, lack of measuring devices and of emergency stock of materials.

IV. Operation of hydropower stations is difficult since mechanical and electrical equipment has been operated already over a long period of time and concrete frames have become deformed and deteriorated.

Among the damages are break of coating and silting of power channels, deterioration of reinforced concrete frames of the headbay, erosion and silting of tailrace channel, waterlogging of HPS building due to backwater of the tailrace, etc.

V. The problem of rock-dammed lakes, the largest of which is Sarez lake, with the volume of more than 16 km^3, always reminds about a need to pay serious attention to natural water bodies in the region, especially in a seismic zone.

The seismic risk of destruction of large hydroschemes is caused by high seismicity of flow generation zones, where dozens of dams are located. Taking into account earthen embankments and high dams this risk raises to hundreds of potential cases. The high seismic activity of the region area calls for special requirements regarding the reliable and safe operation of large structures. These structures located in mountains pose a risk not only for one country but also for downstream neighbors.

Organization of activities on hydraulic structure safety in Central Asia

Since 1999, with enactment of the Law on safety of hydraulic structures, establishment of special authorized agency to monitor safety of hydraulic structures, and adoption of a number of regulations in Uzbekistan, the Republic has begun activities on government regulation of structure safety.

The main aim of this Law is to ensure protection of lives, health, and property of the citizens and industries and prevent destruction of buildings and structures, erosion of soil, hazardous changes in water tables, and other damage in result of failures of hydraulic structures. Therefore, this Law applies to all hydraulic structures, failures of which may cause emergencies threatening lives and health of the people, their livelihoods and vital activity.

In order to enforce this Law, 12 years ago a Decree of the President of Uzbekistan established a State Inspection for monitoring over the state and safety of large and particularly important water facilities – “Gosvodkhoznadzor” at the Cabinet of Ministers.

The main functions of this inspection include state supervision and monitoring over reliability and provision of safety of large and particularly important water facilities together with respective ministries and departments, as well as regulation of matters related to reliable and safe operation of large and particularly important interstate and boundary water facilities.

In order to ensure safety of hydraulic structures, many economic and technical tasks should be solved. The safety also calls for permanent attention by all concerned ministries and departments.

The State Inspection monitors 273 large and particularly important water facilities of class I, II, and III, including 54 reservoirs, 35 pump stations, 29 hydropower stations, 60 main canals, 64 hydroschemes and 24 main collectors, and bank-protection structures on 7 rivers and sais.

392 types of diagnostic work were undertaken in 231 out of 273 water facilities under monitoring. This included inspection and diagnostics of technical conditions, development of an inventory, engineering and geodetic surveys, development of

safety criteria, etc. An inventory was developed and technical inspection was performed for 52 out of 54 reservoirs, diagnostics of technical conditions was made and safety criteria were developed for 21 reservoirs, engineering and geodetic surveys over deformations were made for 44 reservoirs, physical properties and texture of the soil of dams were identified in 2 reservoirs, and probability of seismic risk was assessed in 9 reservoirs.

There is a Council of experts consisting of representatives of the top-level from ministries and large design institutions, leading water sector professionals. Among the main functions of this Council are reviewing and making decisions on the most important matters connected with reliability of hydraulic structures. Decisions of the Council of experts have to be fulfilled by executive authorities in situ, enterprises, institutions and organizations.

Safety declarations were drawn up and approved by the Council for 47 hydraulic structures, of which for 7 structures they were re-developed and for 14 ones returned for improvement. The system of monitoring and assessment of hydraulic structure safety, including a database, is developed and maintained. Monitoring results are submitted regularly to the Ministry of Agriculture and Water Resources, the Uzbek Energy Company, and the BWO Amudarya and Syrdarya for their use in developing and implementing planned rehabilitation of structures.

Based on this experience, with the assistance of UNECE and under financial support of the Finnish Government, as well as in close cooperation with the EC IFAS, a regional project “Dam Safety in Central Asia: Capacity Building and Regional Cooperation” has been implemented since 2004.

The project aims to improve national legislations and strengthen cooperation in area of dam safety. In particular, a model national law “About safety of hydraulic structures” was elaborated for the countries, which lack such law, and an agreement among the Central Asian Governments on safety of hydraulic structures was drafted. In addition, efforts were undertaken to harmonize regulations and training workshops for professional development and experience sharing were held.

The first project phase was implemented in 2004-2006, while the second phase was started in 2006 and is to be completed in June of the current year.

Uzbekistan takes leading position regarding provision of state regulation for safety of hydraulic structures and was the first that developed specific law on safety of hydraulic structures and established an authorized state authority responsible for supervision of technical conditions, operation, and safety of these structures. Similar Law on structure safety was adopted in Tajikistan; however, a regular body for this law enforcement was not established.

Nevertheless, by present, the Central Asian countries moved in establishing a system ensuring safety of hydraulic structures. Taking into account location of large structures on transboundary rivers, the system for state regulation of safety has to be developed and, on its basis, regional mechanisms have to be adopted. To this end, the work on improvement of national legislations and on revision and approval of the

draft regional Agreement about cooperation on hydraulic structure safety among the Central Asian countries is continued.

The efforts of CA countries under the regional cooperation on hydraulic structure safety and support from UNECE, EBRD, UN SPECA Program, World Bank, ADB, GTZ-GIZ, IFAS and other international institutions contribute to building trust, collaboration, and sustainable development in the region.

Recently, the Central Asia has been showing clearly a tendency towards consolidation of the countries in issues related to safety of hydraulic structures, including large dams. This refers to the above-mentioned draft Agreement, joint training for professional development of operating staff, sharing of experience among the countries, and harmonization of safety regulations.

It should be noted that not only the level of safety and operating capacity of some hydroschemes poses a risk for control of structures but also the degree of reconciling of hydroschemes' operation regimes, correspondence of design parameters to flow regimes, critical parameter values, as well as accuracy of hydrological forecasts.

Thus, prevention of risks at structures is transformed into a system of the whole water sector safety.

Thematic direction:
Risk management and water security

Goal: improving reliability of control of a system of structures in their interaction, including those located on transboundary watercourses.

Analysis and assessment of a degree of risk for operating capacity of large hydraulic structures and for their operation regimes in terms of sustainable functioning of the whole water sector, and, based on this, **drawing up of an action plan to reduce the risk and improve reliability**. This target cannot be achieved within the time frame of the 6th World Water Forum; however, actions on organization of this work in the future can be mapped out.

The following measures are proposed:

2.1. Prepare a plan of regulatory and institutional basis in area of large hydraulic structure safety and risk reduction

Proceeding from the analysis of water sector functioning over the last decade, this work should include:

- measures to increase accuracy of flow forecasts regarding watercourses;
- unification of procedural guidelines on risk management on the regional scale;

- setting of limits on non-agreed deviations of flows in watercourses from natural ones or those observed earlier.

Time horizon – until mid 2012.

Stakeholders: BWO Amudarya, BWO Syrdarya, water management organizations, regional; owners of large hydraulic structures, etc.

2.2. Application of information-diagnostic system at hydraulic structures

Supervision and monitoring over technical conditions of hydraulic structures in order to ensure their safety call for development of the information-diagnostic system, which is applied currently in Kyrgyzstan, Tajikistan, and Uzbekistan.

For hydraulic structures falling to a hazard class I, II and III, it is advisable to apply automatic monitoring systems (AMS) for monitoring of the conditions within the framework of IDS. If AMS is unpractical (or impossible) on the above structures, the IDS providing for manual input of observation data can be applied. Development of Feasibility Studies and legal documents – 2012; stakeholders: owners of hydraulic structures.

2.3. Training in provision of hydraulic structure safety for specialists in Central Asian countries

Analysis of recent accidents at hydraulic structures with catastrophic consequences all over the world shows that the major cause of their occurrence is the human factor. About 50% of accidents and related emergencies is a result of poor skills of operating personnel, inadequate organization of work, non-observance of safety rules and norms, and lack of monitoring over structure safety. This noncompliance may lead to accidents with huge property, environmental, and social damage.

The most perfect hydraulic structure, where all innovations are applied and the most rational layout is designed, may be low-effective in case of poor performance. Safety of hydraulic structure calls for highly professional knowledge and responsibility, efficient organization of monitoring over the state of structure, on-line control and operative decisions on prevention and isolation of faults by the operating, construction, design organizations and a state inspection body, as well as needs that laws and regulations be followed properly by these organizations. In this context, a set of measures has to be planned in order to:

- ground the establishment of national training centers and their provision with necessary equipment and training materials;
- organize regular sharing of experience in operation and provision of safety of hydraulic structures.

Time horizon: 2011…2013

Stakeholders: UNECE, BWO Amudarya, BWO Syrdarya, region's water management organizations.

2.4. Development of guidelines on estimation of hydraulic structure's remaining life

Prolonged operation of the most hydraulic structures in Central Asia under limited financial resources often leads to their hazardous conditions and reduced reliability. Further reliable and uninterrupted operation of these structures depends on adequacy of decisions made regarding the safety level of the conditions of operated structure by agencies responsible for safety. Decisions made by agencies responsible for operation must by well-grounded and consider modern approaches to forecasting of structure's conditions depending on failures of resource and structural components. The well-grounded decisions are important for development and implementation of structure repair or reconstruction plans and setting up of first-priority, mid- and long-term measures. Moreover, those should be supported by sufficient financial resources.

In this context, a need arises for the development of guidelines on estimation of hydraulic structure's remaining life.

The guidelines have to contain main provisions on procedure for estimation of remaining life and establish:

1. requirements regarding contents of developed methods for estimation of hydraulic structure's life;
2. if necessary, requirements considering specific conditions of operation and diagnosing of a structure (for example, refined assessment of the mode of deformation, physical and mechanical characteristics of structure's materials, etc.);
3. main provisions describing conception for estimating remaining life, which is the operating time of structure from the point of monitoring over its technical conditions to nonoperable or marginal state;
4. prediction of the remaining life, which should made according to the patterns of changes in key parameters as obtained from analysis of failure development mechanisms and (or) measurements of functional indicators;
5. selection of prediction method, which should be determined by accuracy and reliability of received data, as well as by accuracy and reliability of predicted remaining life and by the risk of continued operation, the availability and reliability of monitoring over conditions of the structure.

Time horizon: 2012…2013
Stakeholders: UNECE, water management organizations, owners of hydraulic structures.

2.5. Developing a system of monitoring and assessment of hydraulic structure safety

Aims and objectives of the safety monitoring are achieved through organization of regular visual observations and measurements that provide qualitative and reliable information in needed volume.

When implementing the system of monitoring and assessment of hydraulic structure safety (MAHSS), the multiple-level tasks integrating components that contribute to system's effectiveness should be solved.

In this context, a need arises for the development of model projects for implementation of the MAHSS systems, where all main objectives, tasks, structure, and content of this system are considered, including application of up-to-date technologies (devices, equipment, software, etc.). Such approach will help to efficient planning and implementation of the MAHSS system when reconstructing, rehabilitating or modernizing hydraulic structure. All this will contribute to comprehensive and reliable analysis and evaluation of forecast of developments in safety of hydraulic structures, to preparation of recommendations on how to overcome negative tendencies and prevent accidents, and to creation of conditions for safe operation of structures.
Time horizon: 2011…2013.

Stakeholders: UNECE, EC IFAS, region's water management organizations.

2.6. Harmonization of engineering regulations on safety of hydraulic structures

Due to prolonged period of operation and obsolescence of hydraulic structures, the risk of accidents increases. As a result, there is a probability of breach of banks, flooding of settlements, motor roads and railways, water-, energy-, and gas-supply systems, irrigated areas and pastures, and deterioration of lands.

Assessment of the current state of hydraulic structures and the level of their operation in the region's countries indicates to a need for harmonization of norms and specifications on safety of hydraulic structures in the following directions:

- unification of channel process assessment techniques;
- bank-protecting and water-training measures in order to control channel erosion, mudflow and protect settlements and buildings;
- exchange of hydrological and meteorological data.

Here it is important to strengthen cooperation among the countries in the region for further improvement of regulatory work and procedures in area of hydraulic structure safety.

2.7. Development of regional cooperation

An increase of safety of interstate hydraulic structures on transboundary watercourses is based on the following:

- agreeing upon a list of hydraulic structures located on transboundary watercourses.
- organizing joint inspection (after agreement by involved countries) of technical conditions of structures.
- developing mutually acceptable rules for safety of hydraulic structures.
- harmonizing the norms and specifications for ensuring safety of hydraulic structures.
- implementing information-diagnostic systems for monitoring over conditions (like BING-3).
- preparing unified national inventories of hydraulic structures that will be useful for achieving compatibility of data on structures located on transboundary watercourses.
- carrying out joint measures to increase safety of structures.
- raising information awareness of management personnel dealing with regulation of safety of hydraulic structures on transboundary watercourses.
- cooperation among national training centers on safety of hydraulic structures.
- effect of safety of large structures on stability and safety of the whole water infrastructure in the region.
- a need to take into account relationship of operating regimes of structures; risk of critical floods (2004, Syrdarya, damage 17 M$) and droughts (2008, damage 200 M$).
- a need to take into account long- and short-term forecasts.
- a need to avoid commercial hydro-egoism threatening the safety of hydraulic structures (on example of Sayano-Shushenks HPS);
- on mandatory basis, construction of new hydraulic structures on transboundary watercourses must be subjected to independent (technical, socio-economic, environmental, etc.) expertise and agreement among all states in the region;
- prior attention to the hydraulic structures located in seismic zones;
- allocation of sufficient funds for maintenance of hydraulic structures on transboundary waters.