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Republic of Tajikistan

Nurek Hydropower Rehabilitation Project

Environmental and Social Impact Assessment

Final Report

Barqi Tojik Open Joint Stock Holding Company

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LIST OF ABBREVIATIONS AND ACRONYMS

%	Percent
BP	Bank Procedures
BVO	Basseynoe Vodnoe Obedinenie / Basin Water Organization
EHS	Environmental Health and Safety
EIA	Environmental Impact Assessment
ESMP	Environmental and Social Management Plan
ESU	Environmental and Social Unit
FAO	Food Heath Organization
FSL	Full supply level
GFI	Ground Fault Interrupter
GWh	Gigawatt per hour
H Res max	Maximum water level in the reservoir
ha	Hectare
HPP	Hydropower plant
IBA	Important Bird Area
ICWC	Interstate Commission for Water Coordination
IUCN	International Union for Conservation of Nature
km^2	Square kilometer
km	Kilometer
Km^3	Cubic kilometer
kV	Kilovolt
l	Litter
L&FS Plan	Life and Fire Safety Plan
LSMS	Living Standards Measurement Survey
m	Meter
m3	Cubic meter
masl	Meter above sea level
mg	Milligram
MIV	Main inlet valve
MW	Megawatt
NGO	Non-Governmental Organization
NOU	Nurek Operation Unit
OP	Operational Policy
PAH	Polycyclic Aromatic Hydrocarbon
PFMA	Potential Failure Modes Analysis
PM	Particulate matter
PMF	Probable Maximum Flood
PPE	Personal Protective Equipment
Q turb max	Maximum turbined flow

Q turb min	Minimum turbined flow
ROR	Run-off river
rpm	rotation per minute
RT	Republic of Tajikistan
SCIDP	Stakeholder consultation and information disclosure plan
sec	Second
SOP	Safe Operating Procedures
TALCO	Tajik Aluminum Company
THC	Tuyamuyun Hydrocomplex
TWh	Terawatt hour
UN	United Nation
USD	United State Dollar
WB	World Bank
WHO	World Health Organization

1. EXECUTIVE SUMMARY

Context & demand

The Nurek Dam, commissioned in 1972, is the highest embankment dam in the world (300-m high). The powerplant is equipped with 3000MW of installed capacity. The dam controls the Vakhsh River which is one of the major tributaries of the Pyanj River which becomes the Amu Darya after its confluence with the Vakhsh and Kotarnihon rivers. The Amu Darya is the largest river of Central Asia, and one of the two main tributaries of the Aral Sea.

Nurek Hydro Power Plant (HPP) is the most important in Tajikistan, because it supplies more than 72% of the electricity produced in Tajikistan. In addition to electricity generation, the reservoir directly supplies irrigation water for about 70,000 ha via a tunnel with additional irrigation of tens of thousands of hectares made possible by the regulation of the Vakhsh River.

However, due to the vibration of the turbines' generators and the fatigue of the runner's metal, the recorded upper limit output was not higher than 2,320 MW (compared to the installed capacity of 3,000 MW). In addition, the sediment accumulation in the reservoir has resulted in a reduction of storage capacity.

The purpose of the rehabilitation project ("the Project") is multiple:

(i) Restore the generation capacity of Nurek HPP through refurbishment of the generating units and the balance of the plant;
(ii) Increase efficiency of the generating units through improved hydraulic design and installation of higher efficiency equipment; and
(iii) Enhance the safety of the Nurek dam through rrehabilitation of spillway tunnels, refurbishment of spillway gates/hoisting system, improvement of protection on permeable zone of the embankment dam above the core zone crest, measures to enhance safety against seism and hydrological risks.

The rehabilitation of the Nurek HPP will be carried out in two phases. The first phase includes the rehabilitation of three generating units and some of the balance of plant[1], and critical dam safety works. The remaining six units and the remaining balance of plant will be rehabilitated in the second phase of the project. The total cost of the Project is estimated at US$700 million, including the cost of the first phase at US$350 million.

The present Environmental and Social Impact Assessment (ESIA) covers the full rehabilitation project.

Baseline synthesis: main issues

[1] Balance of plant: This term refers to all other power plant elements excluding the turbines

For the physical environment, the hydrology and downstream water quality are major aspects on which the study focused. Indeed, downstream of Nurek, many hydroelectric run-of-river dams depend on water released by Nurek HPP, and tens of thousands of irrigated hectares benefit from the regulation effect of the Nurek HPP on the Vakhsh River. Water quality and hydrology have already been impacted by the construction of the dam. The project will not further degrade the quality of the water, especially considering the presence of inhabited areas immediately downstream of the dam and other water uses.

In the project area, terrestrial ecological issues are moderate to low. The presence of protected areas downstream of Nurek, upstream and downstream of the Vakhsh River and Pyanj River confluence have to be kept in mind, particularly because of the existence of Tagai, a specific kind of floodplain habitat in desert areas of Central Asia. Finally, regarding the aquatic environment, even if the dam construction has already impacted reduction of quantities of fish in the area, aquatic life remains a significant component sensitive to industrial water pollution.

The human environment combines various issues notably the presence of Nurek city in the immediate vicinity of the site. The local area traversed by the access road to the site will be impacted by the passage of vehicles carrying people and equipment. Finally, the issue of electricity production is also a key criterion for analyzing the impact of the Nurek HPP project.

Refurbishment methodology

As a base case scenario, it is considered that the units will be taken out of service one after the other for rehabilitation. Under this approach, the Project will be implemented over a period of 10 years.

The first Phase of the Project, including modeling and design of generating units, is scheduled to last 6 years. The site activities are on the critical path and last between 10 and 11 months for each unit (between the dismantling task and the finalization of the test task). Each turbine and generator will be stopped, dismantled, rehabilitated and reinstalled.

An alternative scenario was considered. It assumes taking out of service two units at the same time for rehabilitation in order to reduce the project duration. With this alternative, the Project would be implemented over a period of 7 years and 7 months. However, this alternative was rejected by Tajik Authorities as it introduces limitations in electricity production and difficulties in regular maintenance of the units during the course of the Project.

Therefore the total duration of the Project (stage 1 and 2) is:

1.5 years + 3 months + 10/11 months x 9 units = 10 years

Project impact and proposed measures

The Project involves 20 identified impacts. 16 are negative and 4 are positive. The majority of impacts concern: (i) potential pollution due to refurbishment wastes (hazardous and non-hazardous); (ii) health and safety risks that may affect workers but also local communities; and (iii) regular operation of the power plant. No impact has been identified regarding downstream hydrology, upstream reservoir level and downstream water demand/use. The table below prioritizes these impacts.

Environmental component	Impact						
	Ref.	Source	Type	Description	Project phase		Importance
					Refurbishment	Operation	
Soil, water surface quality	I06	Waste production	Negative	Asbestos removal and manipulation risks	x		High
Health and safety - workers	I06	Waste production	Negative	Asbestos removal and manipulation risks	x		High
Health and safety - workers	I07.3	Work with or close to electrical equipment	Negative	Electrical hazards risks	x		High
Production of energy	I11.2	Involuntary stoppage of one or several units due to issue in refurbishment works	Negative	Electrical production impacts	x		High
Soil, water surface quality	I04	Waste production	Negative	Refurbishment waste pollution	x		Moderate
Water Quality	I05.1	Waste pollution	Negative	Water pollution risk	x		Moderate
Aquatic habitats and fauna	I05.2	Water pollution	Negative	Potential downstream aquatic habitats and fauna perturbation	x		Moderate
Health and safety - workers	I07.2	Noisy tasks	Negative	Noise emission exposure risks	x		Moderate
Health and safety - workers	I07.4	Hot work	Negative	Welding / hot work hazards risks	x		Moderate
Health and safety - workers	I07.5	Increase of vehicles and traffic in Nurek HPP area	Negative	On-site traffic risk	x		Moderate
Health and safety - workers	I07.6	Work at a height	Negative	Working at heights risk	x		Moderate
Health and safety - communities	I09.1	Waste production, spill, etc.	Negative	Risk of exposition to water pollution	x		Moderate
Health and safety - communities	I09.3	Transport of Hazardous Materials	Negative	Transport of Hazardous Materials and risks for communities	x		Moderate
Health and safety - workers	I07.1	Working with or close to moving equipment	Negative	Associated risks with rotating and moving equipment	x		Low
Health and safety - communities	I09.2	Increase of vehicles and traffic in the access road outside Nurek HPP	Negative	Traffic and pedestrian safety risks for communities	x		Low
Dam safety	I11.1	Involuntary stoppage of one or several units due to issue in refurbishment works	Negative	Temporary reduction of spillage capacity	x		Low
Socio-economic local conditions	I12.1	Arrival of workers	Negative	Socio-economic tensions	x		Low
Hydrology	I01	Hydro-electromechanical refurbishment	-	Vakhsh River's downstream flow regime modification			None
Reservoir water level	I02	Modification of the operating rules	-	Nurek HPP reservoir management level modification			None
Dam safety	I03	Modification of the current discharge water capacity	-	Flood risk during refurbishment and operation			None
Climate risk	I13	Reservoir	-	Effects of Nurek Reservoir on local climate			None
Socio-economic local conditions	I12.2	Arrival of workers	Positive	Job opportunities for local populations	x		Low
Socio-economic local conditions	I12.3	Arrival of workers	Positive	Development of economic opportunities	x		Low

Environmental component	Impact						
	Ref.	Source	Type	Description	Project phase		Importance
					Refurbishment	Operation	
Health and safety - workers	I08	Installation of proper aeration, lighting and railing for stairs	Positive	Decrease of working health and safety risks in tunnels		x	Moderate
Dam safety	I10	Implementation of recommendations	Positive	Dam safety improvement		x	High

Three negative impacts were identified as "high":

(i) **Asbestos** is present in equipment that should be refurbished. Asbestos removal and handling represent a major health risk that requires special precaution with respect to workers' health and safety. This risk appears twice because it is direct and indirect (via the pollution of the working environment);

(ii) The dismantling, installation and testing phases in such projects represent **electrical hazards for workers**;

(iii) During the handling of electrical components/devices, involuntary stoppage of one or several units can occur. This can lead to a **reduction of electrical production and the fluctuation of the voltage in the electricity grid**.

To prevent these impacts and risks, the Contractor should implement several environmental plans within an overall Environmental and Social Management Plan to be monitored by the Project owner.

The Environmental Health and Safety plan details the measures for preventing pollution, ensuring waste management and ensuring the safety conditions for workers and communities.

A Pedestrian and Traffic Safety Plan will be implemented to prevent injuries from to project vehicles.

The Emergency Preparedness and Response Plan proposed by the Contractor should include all measures to face an emergency situation (pollution, fire, work incidents, dam operating problems, asbestos spills, etc.).

Finally, the implementations of "work permits" (strict procedure) will ensure the prevention of power plant operation issues.

The Contractor will incur the costs of implementing the Environmental and Social Management Plans (ESMP). The Project Owner (Barqi Tojik) will have a budget for controlling and monitoring ESMP actions. Specifically, Barqi Tojik (BT) has already hired a Project Management Consultant (PMC), which, among other things, will be responsible for supervising the Contractor's compliance with the requirements of ESMP.

The World Bank, through the Environmental Assessment policy (OP 4.01, January 1999), has put forward requirements related to consultation and engagement throughout all project phases, from planning to operation.

The first round of consultations, conducted by the Public Organization "Kuhiston", took place in summer 2016. Beyond the concerns traditionally raised during these meetings (employment of local staff, safety of workers and population, information procedures and follow-up to the consultation, etc.), some issues have been raised, even if they are technically not justified, should be clarified by BT during the subsequent stakeholder engagement activities as detailed in the Stakeholder Engagement Plan (SEP):

(i) **Magnetic field** created by the Nurek HPP, believed to be responsible for cardiovascular diseases;

(ii) Use of **alternative road** to avoid heavy-duty vehicle traffic going through the city of Nurek. In order to divert the traffic, a bridge will need to be used, which is in poor technical condition. This will require assessment of the condition of the bridge. If appropriate, such assessment may be included in the scope of the EPC contractor.

(iii) Potential downstream disasters caused by **water discharges** from the reservoirs on the Vakhsh river. This is not an issue directly related to the Project, but is rather an issue of coordination between the Agency on Land Reclamation and Irrigation and Committee on Emergency Situations together with BT. Clarifications and responses should be provided to population during implementation of SEP to address the concern.

As mentioned above, SEP is proposed in this report to ensure effective engagement with external stakeholders during all phases of implementation of the project. This will also help to effectively communicate project related matters to stakeholders and take into account their feedback.

This Project is considered as a "Project on International Waterways" as per World Bank's Operational Policy 7.50. Therefore, the World Bank sent a notification to riparian countries, based on the request from the Government of Tajikistan, to inform about the project scope and anticipated impacts. The Project will not finance any works that would change the nature of the original Nurek HPP scheme, or so alter or expand its scope and extent as to make it appear a new or different scheme. The Project will not adversely change the quality or quantity of water flows to the other riparians nor be affected by the other riparians' water use.

2. POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

2.1. National regulation

2.1.1. Environmental protection

Several laws exist in the Republic of Tajikistan for environmental protection. The ones to be considered in this project are summarized in the Table 1, with comments if relevant.

2.1.2. Environmental Impact Assessment procedure

The Environmental Impact Assessment (EIA) procedure is defined by the Procedure of Environmental Impact Assessment (No. 464, approved October 3, 2006). This text contains a detailed description of the procedure to be followed for the preparation of impact assessment studies.

Appendix 1 of the Procedure defines the projects for which an EIA is required. Amongst such projects are: “Hydropower, thermal power plant and other facilities with thermal output of 300 Megawatt” and “Large dams and reservoirs”. Nevertheless, refurbishment projects of large dams or projects that can potentially modify water flow are not listed.

Appendix 4 of the Procedure provides an EIA procedure flow chart (see Figure 1).

Table 1 – National Regulation on Environmental Aspects

Regulation	Reference	Subject
Water Code	News of Majlisi Oli of the Republic of Tajikistan 2000, n°11, art. 510; 2006, n°3, art. 164	The purpose of the Water Code is to regulate water relations in order to ensure the rational use of water for the needs of the population, branches of economy and the natural environment, protection of water from pollution, damage and exhaustion, preventing and liquidating adverse impact of water, improvement of condition and protection of water bodies, strengthening of lawfulness and protecting the rights of individuals and legal entities in the field of water relations. In this Code, Owners of hydropower dams have the right to carry out improvements of use of water reservoir for the purposes of energy, as long as it does not violate the requirements of complex use and protection of water. Some of the obligations of hydropower project Owners are the following: - To provide free passage and safety of water transport, boats, and to carry out sanitation passage of water and protection of water according to the designs; - To maintain fish protection facilities, fish passage and spawning facilities, and protect water flora and fauna.
Law No. 760 "On environmental protection".	2 August 2011	This Law establishes legal grounds of state policy in the sphere of environmental protection and is aimed at ensuring sustainable development, healthy and favourable environment, prevention of negative environmental impact, ecological safety and rational use of natural resources. The Act consists of 17 Sections divided into 85 articles: (1) general provisions; (2) competence of state executive bodies in the sphere of environmental protection; (3) rights and duties of citizens, public associations and other non-governmental entities in the sphere of environmental protection; (4) economic regulation in the sphere of environmental protection; (5) rate setting of environmental standards; (6) environmental impact assessment and environmental audit; (7) ecological requirements applicable to location, construction and putting in operation of enterprises, edifices and works; (8) ecological requirements applicable to the functioning of enterprises; (9) environmental emergencies and disasters; (10) environmental statistics; (11) protected areas; (12) observation of the state of environment; (13) environmental control; (14) environmental audit; (15) environmental education; (16) liability, compensation and dispute settlement; and (17) conclusive provisions.

Regulation	Reference	Subject
		This law repeals Law No.905 of 1993 on environmental protection (Bulletin of Supreme Council (Shuroi Oli) of the Republic of Tajikistan, dated 1994, No2, Article 36, news of Majlisi Oli of the Republic of Tajikistan, dated 1996, No3, Article 48, 1997, No23-24, Article 333, 2002, No 4, Part 1, Article 245, 2002, No 11, Article 708, 2004, No7 Article 465, 2007, No c6, Article 440)
Law No. 786 "On protected areas"	26 December 2011	This Law establishes legal, organizational and economic basis of protected areas, tasks, functioning and zoning thereof. The Act consists of 13 Sections divided into 53 articles: (1) general provisions; (2) management of protected areas; (3) organization of protected areas; (4) state nature reserves; (5) national parks; (6) state wildlife sanctuaries; (7) state zoological parks; (8) state nature monuments, and ecological and ethnographic areas; (9) dendrological parks and botanical gardens; (10) natural resorts, medicinal, healthcare and recreational areas; (11) protected areas of international significance; (12) modalities of protection of protected areas; and (13) conclusive provisions. Protected areas shall be classified as international, national and local (Art. 3). Protected areas shall be exclusive property of the state (Art. 4). Social associations and citizens shall take part in organization, protection and management of protected areas (Art. 9). Protected areas shall be subject to state registration (Art. 10). Land of protected areas shall pertain to state forest fund classified as land of nature protection, recreational, historical and cultural heritage (Art. 16). Protected areas shall be used by citizens for recreational, healthcare, cultural purpose and for ecological tourism (Art. 18). Protected areas shall carry out the following tasks: (a) conservation of biodiversity; (b) biological monitoring; (c) research; (d) participation in environmental audit; (e) staff training; and (f) spreading of ecological knowledge (Art. 20).
"industrial and consumer waste"	News of Majlisi Oli of the Republic of Tajikistan 2002, , n°4, part-1,art 287,2005, n°7 art 409	This Law regulates relations originating from waste production, collection, storage, utilization, transportation, recycling and burial and has as its scope prevention of negative environmental impact of waste. The Act consists of six Chapters divided into 22 articles: (1) general provisions; (2) competence of the state bodies in the sphere of waste management; (3) requirements for waste management; (4) supervision over waste management; (5) registration; and (6) economic and legal regulation in the sphere of waste management. The basic principles of the state policy in the sphere of waste management shall be: (a) priority of environmental protection; (b) combination of ecological and economic interests; (c) introduction of low-waste technologies; (d) observance of environmental and sanitary legislation; (e) enforcement of sanitary, hygienic and ecological rules and regulations; and (f) access to information. Waste management activity shall be subject to licensing. Burial of waste in the urban areas, on the territory of forest parks, health resorts, and water conservation areas of groundwater used for potable water supply

Regulation	Reference	Subject
		shall be prohibited. Amended by Law No. 736 (28 July 2011)
Law No. 228 on "protection of the atmospheric air"	News of Majlisi Oli of the Republic of Tajikistan 1996, n°3,art53,1997, n°23-24,art333,2007, n°5 art 370	This Law establishes that the purposes of protection of the atmospheric air shall be: (a) to ensure favourable environment; (b) conservation of air quality; (c) state supervision of atmospheric air of inhabited areas; and (d) enforcement of legislation in the sphere of atmospheric air. The Act consists of ten Sections divided into 36 articles: (1) general provisions; (2) rights and duties of citizens; (3) air quality rate setting; (4) economic mechanism of protection of the atmospheric air; (5) environmental audit; (6) atmospheric air protection requirements in the process of economic activity; (7) registration of emissions; (8) dispute settlement; (9) liability; and (10) international cooperation. The authorized state institution in the sphere of protection of the atmospheric air shall be the Ministry of Environmental Protection. Air quality standards shall establish: (a) maximum concentration of pollutants in the atmospheric air; (b) maximum emission limits for stationary and non-stationary sources; and (c) maximum limit of electro-magnetic pollution. Pollution of the atmospheric air by emissions shall be charged. Protection of ozone layer shall be carried out by reduction of ozone depleting substances Amended by Law No. 498 (12 December 1997).
Law No. 705 "On ecological information"	25 March 2011	This Law establishes legal, organizational, economic and social grounds for the provision of ecological information, granting access to reliable, complete and timely ecological information to natural and legal persons. Ecological information shall include: (a) state of environment, including atmospheric air, surface and groundwater, flora and fauna, landscapes and GMO; (b) energetic pollution, noise pollution, electromagnetic pollution and radioactive pollution; (c) decisions of governmental bodies related to negative environmental impact and environmental pollution; (d) public health and safety of citizens; and (e) living conditions and environmental impact (Art. 3). Natural and legal persons shall be granted free access to ecological information (Art. 4).
Law No. 707 "On ecological monitoring"	25 March 2011	This Law establishes organizational, legal, economic and social basis for ensuring ecological monitoring. The Act consists of 5 Sections divided into 22 articles: (1) general provisions; (2) organization of state system of ecological monitoring; (3) competence of the state executive bodies in the sphere of ecological monitoring; (4) regulation of activity in the sphere of ecological monitoring; and (5) conclusive provisions. Ecological monitoring shall be carried out for the following purposes: (a) observation of the state of environment; (b) environmental impact assessment (EIA); (c) access to reliable environmental information.

Regulation	Reference	Subject
		Ecological monitoring shall carry out the following tasks: (a) regular observations of environment; (b) creation of environmental database;(c) forecast of environmental changes; (d) elaboration of programmes, proposals and arrangements for the liquidation of the consequences of negative environmental impact; and (e) informing state bodies, natural and legal persons on the state of environment (Art. 3).
Law No. 818 "On environmental audit"	16 April 2012	This Law establishes principles and modalities of conducting environmental audit and is aimed at prevention of negative environmental impact of projected economic activity. Basic principles of state policy in the sphere of environmental audit shall be: (a) assumption of ecological hazardousness of projected economic activity; (b) obligatoriness of state environmental audit; (c) obligatoriness of consideration of ecological safety in the process of environmental audit; (d) reliability and completeness of information submitted for environmental audit; (e) independence of experts; and (f) transparency and public participation. Environmental audit shall achieve the following goals: (a) efficiency assessment of measures adopted for the protection of public health, rational management of natural resources and environmental protection; (b) assessment of correct evaluation of ecological risks by the customer; and (c) assessment of possible ecologically negative impact on environment. Environmental audit shall be state and public. Period of validity of state environmental audit shall be limited to the period of project realization.
Law No.20 on "ecological expertise"	22 April 2003 News of Majlisi Oli of the republic of Tajikistan 2003, n°4, art. 150, 2005, n°12, art. 638, 2007, n°7 art. 690	The present Law regulates general order of the organization and carrying out ecological expertise, establishes the rights and the obligations of the parties engaged in carrying out ecological expertise, establishes the rights of the citizens to access to information on ecological danger of the objects in course of projecting, under construction and put into operation, the modalities of appeal against the resolution and dispute settlement, and establishes liability for the infringement of the legislation in the field of ecological expertise. The document consists of VIII Chapters that contain 34 Articles. Chapter I (arts. 1-9) lays down general provisions. Chapter II (Arts.10-14) determines competence of state institutions, local executive authority, social associations and citizens in the field of ecological expertise. Chapter III (Arts.15-20) regards state ecological expertise. Chapter IV (Arts.21-25) regards public ecological expertise. Chapter V (Arts.26-27) regards assessment of environmental impact of new objects and projected activities. Chapter VI (art. 28) establishes rights and duties of customers, projectors and third persons. Chapter VII (Arts.30-31) regards financing of ecological expertise. Chapter VIII (Arts.32-34) lays down final provisions.
Law No. 354 on wildlife	5 January 2008 News of Majlisi Oli of the	Wildlife in Tajikistan shall be exclusive property of the state that ensures protection and efficient management thereof in the interests of the people. By purposeful use wildlife shall be classified as: (a) rare

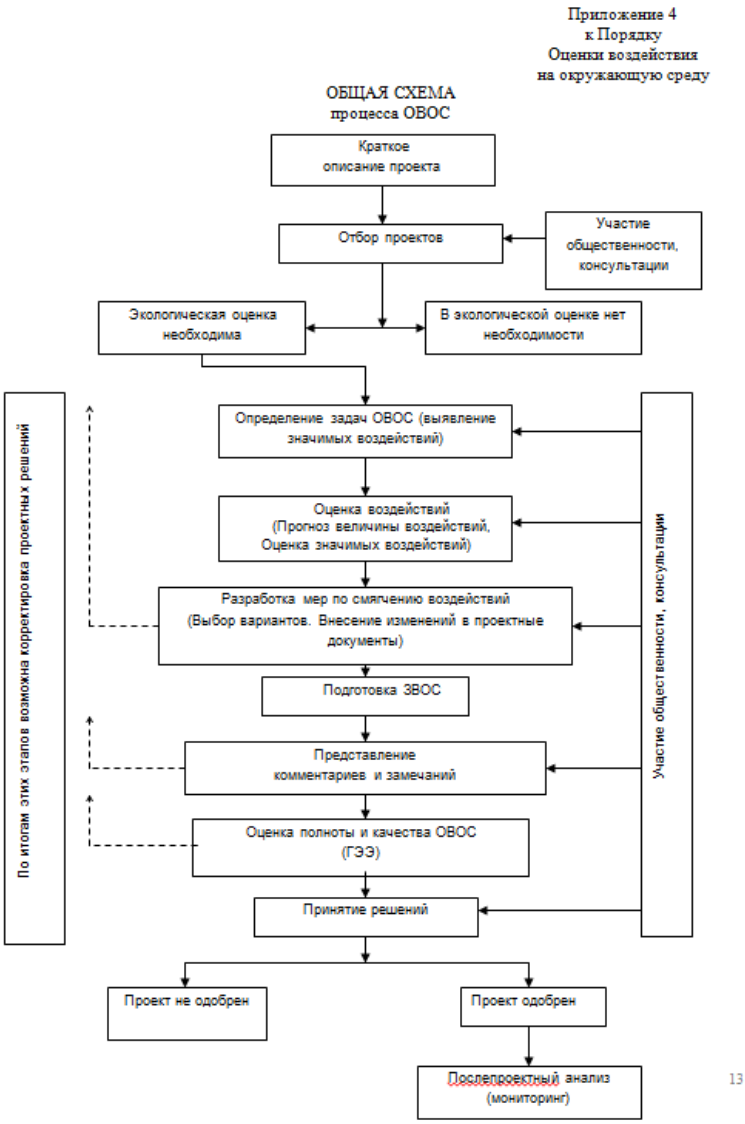
Regulation	Reference	Subject
(Fauna)	Republic of Tajikistan, 2008, n°1 part 2, art 19	and endangered species; (b) species subject to hunting; (c) species used for other economic purposes as established by the authorized institution; (d) species not used for economic purposes but representing ecological, cultural and other value; (e) species subject to regulation for the prevention of harm to agricultural and domestic animals, and also to environment. Authorized state institution in the sphere of management of the objects of wildlife shall have the following competence (a) compilation of the list of animals prohibited for hunting; (b) establishment of rules and regulations for the protection, rational use and reproduction of wildlife, setting quotas for the use of wildlife; (c) suspension of activities that may damage reproduction sites, migratory routes, and also suppression of illegal hunting; (d) wildlife monitoring. Wildlife management shall be general (use of wildlife species and wildlife products without removal thereof from natural environment) and special (use of wildlife species and wildlife products with removal thereof from natural environment). Special wildlife management shall be carried out in accordance with licence issued in accordance with the procedure established by the national legislation. The authorized state institution by agreement with local self-government shall issue authorization for wildlife management. Priority right of wildlife management shall be granted to land tenants of hunting reserves and natural habitats of wildlife species that are not subject to hunting. Objects of the wildlife may be granted for open-ended use to legal and natural persons by way of allotment of land and assignment of hunting grounds thereto. Managers of the objects of wildlife may grant the objects of wildlife to legal and natural persons on contractual basis. Hunting may be carried out by professional, artisanal and sport hunters. Hunting right shall be granted fro 18 years of age (for hunting with firearms), 14 years of age (hunting with other authorized hunting gear, by authorized hunting methods, hunting dogs and hunting birds). Hunting right shall be granted to persons who have passed hunting examination, paid hunting dues and have obtained hunting authorization. Hunting rules and regulations shall be established by the Government. Unauthorized capture and destruction of all types of snakes and other reptiles except for residential areas and resorts shall be prohibited. Capture of snakes and other reptiles shall be carried out exclusively in accordance with permits issued by the authorized wildlife management body. Special wildlife management shall be fee-paying. For the purpose of conservation and reproduction of wildlife species may be imposed the following restrictions: (a)restriction of the period of wildlife management; (b) prohibition of some hunting methods and hunting gear; (c) modification of quotas of removal of wildlife species; (d) restriction of the number of wildlife managers. Hunting shall be incompatible with the purpose of wildlife reserves and shall be prohibited on the territory thereof. In wildlife sanctuaries and in other protected areas some types of wildlife management may be restricted or prohibited. Use of migratory, rare and endangered species for scientific research purpose, with the view of rising up the number thereof shall be allowed in accordance

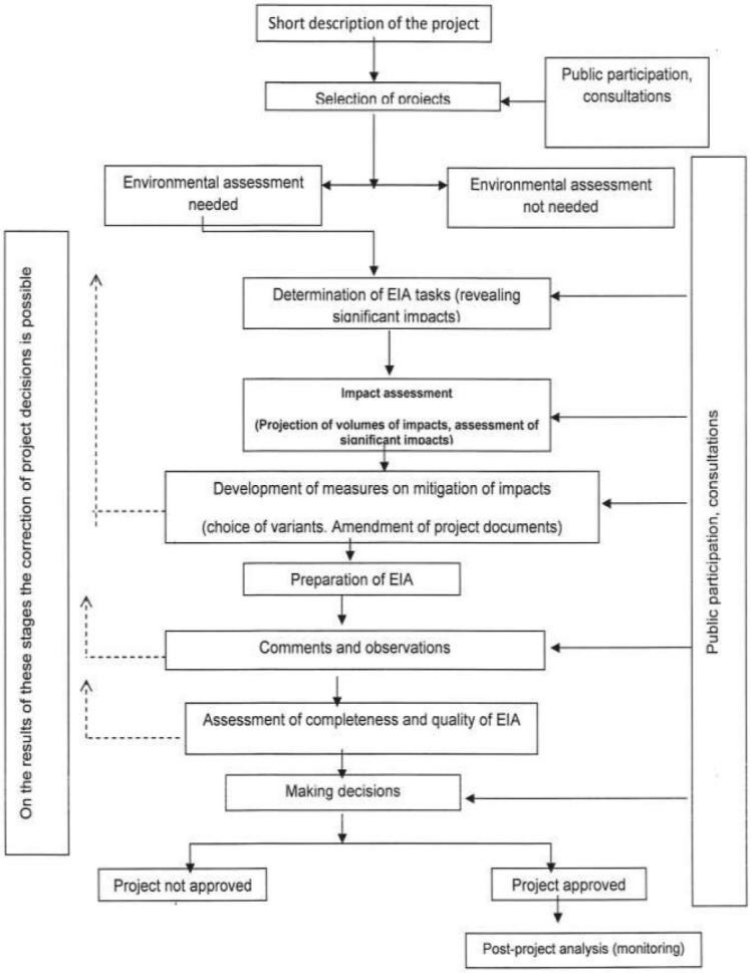
Regulation	Reference	Subject
		with the permit issued by the authorized wildlife management body. Repopulation, acclimatization and cross-breeding of animals shall be allowed for scientific research and economic purpose in accordance with the conclusion of the competent scientific research organizations and exclusively by permits issued by the authorized wildlife management body. Unauthorized repopulation, acclimatization and cross-breeding of animals shall be prohibited. Repeals the law on the protection and use of the animal world (No. 989 of 1994).
Law of the Republic of Tajikistan on "Protection and Use of Flora"	News of Majlisi Oli of the Republic of Tajikistan 2004, n°5,art342,2007, n°7,art 691,2008, n°1 part2 art 18	This Law establishes the principles of state policy of the Republic of Tajikistan in the field of protection and rational use of flora, determines the legal, economic and social basis in this sphere and is directed to preserving and reproduction of resources of flora.
Forest Codex of the Republic of Tajikistan	Gazette of the supreme soviet of the Republic of Tajikistan.1993, n°13 art. 243, news of Majlisi Oli of the Republic of Tajikistan 1997, n°9 art 117	The present Code regulates forestry aiming at the rational use of forest resources, the protection and conservation of the natural environment and the promotion of the production of timber and agricultural products. Forests are declared to be common property of the people of Tajikistan and as such are owned by the state. All forests together form the "unified state forest reserve". Articles 6 and 7 define the competence of the Government and local authorities (" hukumats") in regulating matters relative to forestry. Management of forests and their conservation shall primarily the responsibility of the Forestry Production Association ("Tajikles") and its local branches (art. 8). Article 10 provides for monitoring of forest resources. Management of state forest shall be entrusted to forestry enterprises of the forestry authorities (art. 15). Forests are classified into groups according to their economic importance or protection function (sects. 17 to 19). Sections 20 and 21 provide for transformation of forest land into land for other use. Articles 22 to 25 regulate the use of forests. Forests may be leased from Tajikles. This authority may also grant other forms of forest use in accordance with articles 26 to 28. Articles 29 to 32 regulate procurement of timber. Other forest uses such as hunting, grazing, and gathering of forest products may be granted in accordance with articles 33 to 36. The second part of this Act concerns the protection and conservation of forests and the increase of forest production. Restoration of forests shall be carried out in keeping with provisions of article 38. Tajikles, the Hukumats, as well as collective forest farms shall have the right of "suppression and prevention of violation of the rules of safe keeping and protection of forests" (art. 45). The last part of this Act provides for miscellaneous matters such as the forest cadastre (art. 49), responsibility for the violation of legislation,

Regulation	Reference	Subject
		and the precedence of international agreements over national legislation. (59 articles) Implemented by Decree of the Supreme Soviet of the Republic of Tajikistan on the Introduction and Implementation of the Forest Code of the Republic of Tajikistan (No. 770 of 1993). - 24 June 1993 and Ministerial Decree No. 134 validating the Regulation on the State Forest Service. - 07 April 1999
The Law of the Republic of Tajikistan "On safety of hydro-technical utilities"	29 December 2010	This Law regulates relationships emerging from the activity aimed at ensuring safety during design, construction, capital repair, commissioning, period of operation, reconstruction, rehabilitation, conservation and liquidation of the hydraulic engineering facilities. Its sets the responsibilities of the relevant state bodies, owners of the hydro-technical facilities and user of these facilities (both individuals and institutions) with regard to ensuring safety of hydraulic engineering facilities
Law of the Republic of Tajikistan on Special Natural Territories and Objects	News of Majlisi Oli of the Republic of Tajikistan 1996, n°23,art 353,1998, n°10, art125, 2002, n°4 part -1, art272	-

Sources: http://faolex.fao.org/faolex/index.htm, Rogun ESIA report (2014)

Figure 1 - EIA procedure in Tajikistan (in Tajik and English)





2.2. Central Asia water management agreements

2.2.1. Protocol 566

Prior to independence in 1991, the Soviet Union became concerned about the water crisis of the Aral Sea, which occurred in the late 1980's. The water allocation among the Soviet Republics of the Aral Sea Basin was thus established in a series of resolutions and protocols:

The Scientific and Technical Council of the Ministry of Water Resources established water distribution limits for the Amu Darya basin on March 12, 1987 (see Table 2). The four Soviet riparian states of the Amu Darya basin (Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan) formally endorsed this agreement in Moscow on September 10, 1987 as **Protocol 566**[2]**.** This agreement was concluded in order to limit water use in the basin and to secure additional flows (called Ecological/Sanitary flows) to the Aral Sea.

[2] Protocol 566: *Improvement of the Scheme on Complex Use and Protection of Amu-Darya Water Resources by Scientific & Technical Council*, Ministry of Land Reclamation and Water Management of the USSR, September 10, 1987.

The protocol addresses water sharing principles between the Soviet Union countries, assuming Afghanistan would abstract 2,100 million m^3/yr.

Protocol 566 is still used today as a reference document for discussions on water allocation between the four countries of the Amu Darya basin.

Table 2 - Water distribution limits in the Amu Darya Basin

Country	Maximum allocation (million m^3/year)	Share percentage (%)
Kyrgyz Republic	400	0.7
Tajikistan	9,500	15.4
Uzbekistan	29,600	48.1
Turkmenistan	22,000	35.8
Total for basin	**61,500**	**100**
Downstream of Kerchi		
Uzbekistan	22,000	50
Turkmenistan	22,000	50

The protocol gives no information on the way these annual water allocations shall be split in time (during the year) or in space (by sub-basin).

In this Protocol, the Rogun and Zeid reservoirs were considered constructed (Zeid was already built at the time). These reservoirs and the coordinated operation of water infrastructures within the Amu Darya basin shall guarantee the availability of 61,500 million m^3 of water every year (without Rogun and Zeid, and with only Nurek and Tyuyamuyun reservoirs as major regulating structures, the guaranteed volume was 54,600 million m^3).

In the water allocation context, it is useful to take note of the related issues of the Syr Darya Basin. Syr Darya and Amu Darya basins indeed constitute the Aral Sea Basin, which has been treated as a unit for many decades. The Aral Sea Basin extends over five Soviet Republics, namely Kazakhstan and the four riparian states of the Amu Darya.

Two Basin Water Organizations (BVO, Basseynoe Vodnoe Obedinenie) were created during Soviet times, one for the Amu Darya, and one for the Syr Darya).

2.2.2. September 19, 1988 Decree

In accordance with the objective of Protocol 566, on September 19, 1988, the Council of Ministers of the Soviet Union issued **Decree 1110,** "*Measures for Radical Improvement of Ecological and Sanitary Situation in the Region of the Aral Sea, Enhancing the Efficiency and Use to Strengthen the Protection of the Water and Land Resources in its Basin*".

This Decree specified minimum inflow volumes for the Amu Darya and Syr Darya and to the Aral Sea (including drainage waters) as follows: 8,700 million m^3 in 1990; 11,000 million m^3 in 1995; 15,000 million m^3 in 2000; and 20,000 million m^3 by 2005. These annual minimum environmental flow volumes to the Aral Sea agreed upon in this Decree are still considered to be valid by the four countries.

2.2.3. October 12, 1991 Declaration

On October 12, 1991, a joint statement of the Water Ministers of the five post-Soviet states in the Aral Sea basin (Kazakhstan, the Kyrgyz Republic, Tajikistan, Turkmenistan and the Uzbekistan) was issued with regards to compliance and continuity in the allocation of water to the various Republics.

2.2.4. February 18, 1992 Agreement

On February 18, 1992, within a year of their independence, these five Central Asian countries signed an agreement regarding transboundary water resources[3]. The "*agreement on cooperation in joint management, use and protection of interstate sources of water resources*" or **Almaty agreement**. In this agreement, they agreed to maintain and adhere to the sharing of the transboundary water resources as set out in Protocol 566 for the Amu Darya (and in another document, Protocol 413, for the Syr Darya[4]).

These agreements form the basis for the current water allocation practice among the Central Asian states (Kyrgyzstan, Tajikistan, Uzbekistan and Turkmenistan for the Amu Darya basin). The Almaty agreement established an Interstate Commission for Water Coordination (ICWC) and designated it as the body responsible for the definition of seasonal allocations in line with the annual agreements. The Syr Darya BVO and the Amu Darya BVO are the operative branches of the ICWC.

2.2.5. September 20, 1995 Nukus Declaration

Although it does not specifically refer to Protocol 566, the **Nukus Declaration** restates this agreement on water sharing that allots a percentage of annual river flow to each state along the river.

2.3. International agreements

Several international agreements have been signed or ratified by the Republic of Tajikistan. The ones to be considered are summarized in the following table, and their relevance to the project is given.

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[3] *Agreement between the Republic of Kazakhstan, the Kyrgyz Republic, the Republic of Tajikistan, Turkmenistan and the Republic of Uzbekistan on cooperation in interstate sources' water resources use and protection common management*, February 18, 1992.

[4] Protocol 413: *Improvement of Scheme of Complex Use and Protection of Water Resources of Syr-Darya Basin*, February 7, 1984.

Table 3 – International agreements

Name	Objective	Relevance for Nurek HPP
Aarhus Convention http://www.unece.org/env/pp/introduction.html	The UNECE Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters was adopted on 25th June 1998 in the Danish city of Aarhus at the Fourth Ministerial Conference in the 'Environment for Europe' process. Tajikistan has ratified the convention on 17.07.2001. The Aarhus Convention is a new kind of environmental agreement. The Convention: • Links environmental rights and human rights • Acknowledges that we owe an obligation to future generations • Establishes that sustainable development can be achieved only through the involvement of all stakeholders • Links government accountability and environmental protection • Focuses on interactions between the public and public authorities in a democratic context. The subject of the Convention goes to the heart of the relationship between people and governments. The Convention is not only an environmental agreement; it is also a Convention about government accountability, transparency and responsiveness. The Aarhus Convention grants the public rights and imposes on Parties and public authorities' obligations regarding access to information and public participation and access to justice. The Aarhus Convention is also forging a new process for public participation in the negotiation and implementation of international agreements.	**Relevant in the ESIA process.**
Convention on Wetlands of International Importance (Ramsar, Iran, 1971), called the "Ramsar Convention" www.ramsar.org	The Convention's mission is "the conservation and wise use of all wetlands through local and national actions and international cooperation, as a contribution towards achieving sustainable development throughout the world".	The Convention on Wetlands came into force for Tajikistan on 18 November 2001. Tajikistan presently has 5 sites designated as Wetlands of International Importance, with a surface area of 94,600 hectares. None of these sites will be affected by Nurek HPP Rehabilitation.
CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora)	International agreement between governments. Its aim is to ensure that international trade in specimens of wild animals and plants does not threaten their survival.	Tajikistan is not a contracting party. Not of relevance for Nurek HPP

Name	Objective	Relevance for Nurek HPP
www.cites.org		
Berne Convention (Convention on the Conservation of European Wildlife and Natural Habitats; in force since 1 March 2002) http://www.coe.int/t/dg4/cultureheritage/nature/bern	Its aims are to conserve wild flora and fauna and their natural habitats, especially those species and habitats whose conservation requires the cooperation of several states. Particular emphasis is given to endangered and vulnerable species, including endangered and vulnerable migratory species	Tajikistan is not a contracting party. Not of relevance for Nurek HPP Rehabilitation
Convention on the Conservation of Migratory Species of Wild Animals (also known as CMS or Bonn Convention; in force since 1979) http://www.cms.int/en/country/tajikistan	The Convention aims to conserve terrestrial, aquatic and avian migratory species throughout their range. It is an intergovernmental treaty concerned with the conservation of wildlife and habitats on a global scale.	The Convention on the Conservation of Migratory Species of Wild Animals came into force for Tajikistan on February 2001. Not of relevance for Nurek HPP rehabilitation
UN Convention on Biodiversity (part of the Rio Convention) http://www.cbd.int/countries/default.shtml?country=tj	The objectives of this Convention are the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources, including by appropriate access to genetic resources and by appropriate transfer of relevant technologies, taking into account all rights over those resources and to technologies, and by appropriate funding	The Convention on Biological Diversity came into force for Tajikistan on 29 October 1997. Not of relevance for Nurek HPP rehabilitation
Convention on Environmental Impact Assessment in a Transboundary Context, signed in Espoo, Finland in1991, entered into force in 1997 http://www.unece.org/fileadmin/DAM/env/eia/subregions/central_asia.htm	The Espoo is a United Nations Economic Commission for Europe (UNECE). It sets out the obligations of Parties (contracting States) to carry out an environmental impact assessment of certain activities at an early stage of planning. It also lays down the general obligation of states to notify and consult each other on all major projects under consideration that are likely to have a significant adverse environmental impact across boundaries.	Tajikistan is not a contracting party.
World Heritage Convention (WHC), into force on December 1975 http://whc.unesco.org/en/list	Convention concerning the Protection of the World's Cultural and Natural Heritage.	Tajikistan presently has 2 properties designated as World Heritage site (cultural: Proto-urban Site of Sarazm; natural: Tajik National Park (Mountains of the Pamirs)). None of these sites will be affected by Nurek HPP Rehabilitation
UN Convention to Combat Desertification (part of the Rio Convention, into force on December 1996) www.unccd.int	The Convention is “the first and only internationally legally binding framework set up to address the problem of desertification. The Convention is based on the principles of participation, partnership and decentralization”.	Accession of Tajikistan on 16 July 1997 Not of relevance for Nurek HPP rehabilitation

2.4. International standards: World Bank safeguards

The World Bank is providing the financing that covers the refurbishment project studies, including the present ESIA. As such, the project must comply with all World Bank safeguards and policies relevant for this project. The main applicable international standards for the Nurek HPP Project ESIA are the Operational Policies (OP) of the World Bank (WB).

Regarding the characteristics of the project, three OP are applicable:

- **OP 7.50 "Project on international waterways"**

Regarding the Operational policy OP 7.50 "Project on international waterways" (World Bank, 2013), the following can be considered as an international river:

a. any river, canal, lake, or similar body of water that forms a boundary between, or any river or body of surface water that flows through, two or more states;
b. any tributary or other body of surface water that is a component of any waterway described in (a) above; and;
c. any bay, gulf, strait, or channel bounded by two or more states or, if within one state, recognized as a necessary channel of communication between the open sea and other states and any river flowing into such waters.

The Vakhsh River can therefore be considered as an international waterway. The policy applies, inter alia, to hydroelectric projects that involve the use or potential pollution of international waterways. Therefore, at the request of the Borrower, the Bank sent a notification letter to riparians. The notification letter contained description of the project components, project cost, and confirmation the conclusion from this ESIA report that the project will not impact downstream water releases from Nurek HPP.

- **OP 4.01 "Environmental Assessment"**

This OP governs the environmental impact studies, with associated appendices: Appendices A (Definitions), B (Content of an EIA report) and C (Environmental Management Plan).

As indicated in the Terms of Reference (ToR), the project is part of the Energy Loss Reduction Project which has the highest safeguards category (A). Thus, even if the refurbishment of Nurek HPP is expected to have moderate environmental impacts and would be categorized a B project, the highest safeguards are considered for this ESIA.

The World Bank in its Environmental Assessment policy (OP 4.01, January 1999) has requirements related to information disclosure, consultation and engagement throughout all project phases, from planning to operation. Meaningful consultation must be undertaken about a project's environmental and social aspects with relevant stakeholders in order to take their views into account.

- **OP 4.37 “Safety of Dams”**

This project relies on the performance of an existing dam. For this kind of project, the WB requires that the borrower arranges for Panel of Experts (PoE) to: (a) inspect and evaluate the safety status of the existing dam, its appurtenances, and its performance history; (b) review and evaluate the owner's operation and maintenance procedures; and (c) provide a written report of findings and recommendations for any remedial work or safety-related measures necessary to upgrade the existing dam to an acceptable standard of safety. BT completed selection of PoE, which includes an experienced dam safety specialist, geologist, and an electro-mechanical expert. PoE had the first meeting at the dam site in October 2016.

- **World Bank Policy on Access to Information**

The Bank's disclosure policy is set out in the World Bank Policy on Access to Information, which became effective on July 1, 2010. Underlying the policy is the principle that the World Bank will disclose any information in its possession that is not on its list of exceptions. The policy also outlines a clear process for making information publicly available and provides a right to appeal if information-seekers believe they were improperly or unreasonably denied access to information or there is a public interest case to override an exception that restricts access to certain information.

3. PROJECT DESCRIPTION

3.1. Current Nurek HPP description

3.1.1. General Background

The Nurek Dam is a 300 m high embankment dam. It controls the Vakhsh River and is located about 75 km east of Dushanbe. The Nurek Dam reservoir is the largest reservoir in Tajikistan with a capacity of 10.5 km³ with a reservoir length of over 70 km and surface area of over 98 km². In addition to electricity generation, the reservoir supplies irrigation water to about 70,000 ha via a 14 km irrigation tunnel. The Nurek Dam is located at 30 km upstream of Baipaza dam.

The construction of Nurek's hydro unit began in 1961 and the first turbine began operating in 1972. By 1979, the power plant had 9 turbines, with a capacity of 300MW each (giving a total of 2700 MW). In 1988 the hydropower capacity was increased to 3,000 MW. The long term average annual hydropower production is 11.2 TWh.

3.1.2. Configuration and brief description of the main structures

HPP main structures include the following:

- Embankment dam;
- Flood control spillway with surface water intake;
- Flood control spillway with submerged water intake;
- HPP water intake;
- Penstocks;
- Turbine hall (HPP powerhouse);
- 220kV switchyard;
- 500kV switchyard;
- Access roads;
- Reservoir and river bed.

Water is supplied to the units through three headrace tunnels, 395 to 450-meters long with a diameter of 10 meters. The tunnels have collectors at the end with three pressure channels, 6-meter diameter each and 610 to 666-meters long.

The height of the dam is 300 meters making it the highest dam in operation in the world; the reservoir surface is 98 km² with the volume of 10.5 km^3 and length around 70 km.

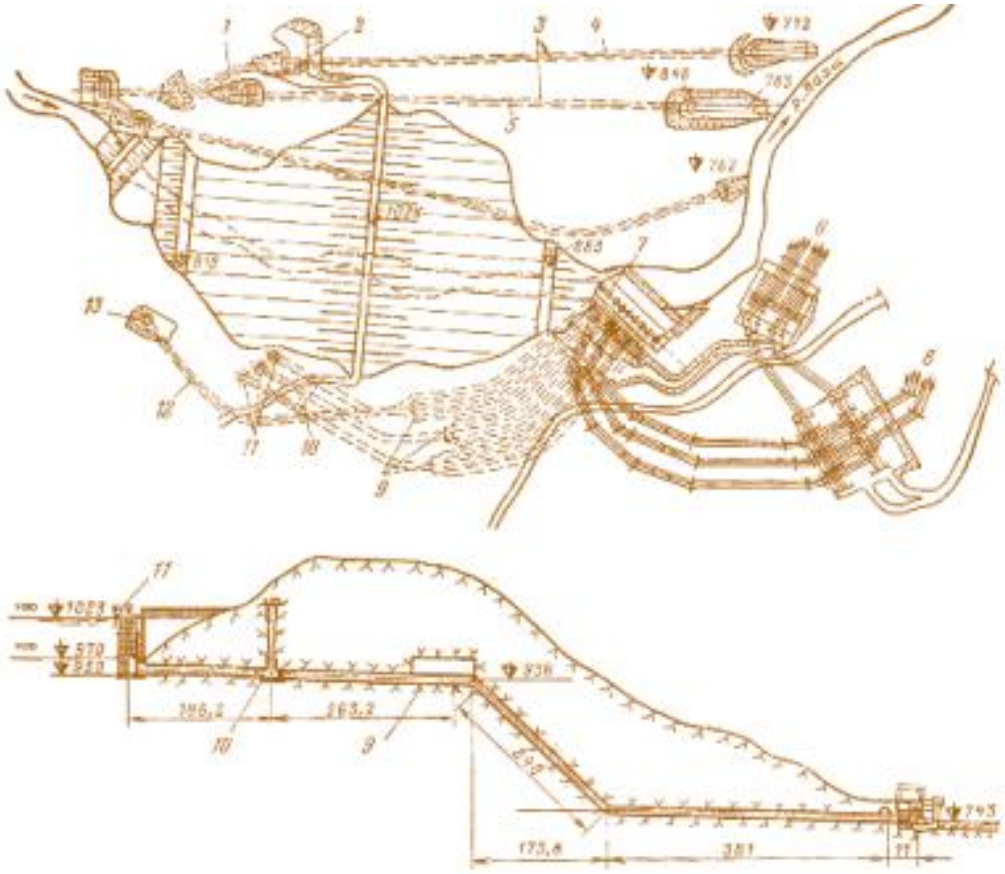
Nine hydraulic units are located in the powerhouse, each unit being equipped with a Francis turbine (diameter of the impeller or runner is 4.75 m at 223 m working nominal head).

Water taken from the reservoir is used not only for power production but also to supply irrigation water to the agricultural lands through a dedicated tunnel.

3.1.3. Plant general layout

In order to clearly identify each area of the power plant, the following designations will be used in the report:

Figure 2 - Nurek HPP layout



Nurek HPP: а - layout; б - longitudinal section of HPP headrace tunnel; 1 - submerged crown of spillway; 2 - surface crown of spillway;
3 - flood spillway; 4 and 5 - construction tunnels of 3rd and 2nd tier; 6 - 220 kV switchyard; 7 - HPP powerhouse; 8 - 500 kV switchyard; 9 - Y-splice premise; 10 - emergency gate valve; 11 - water intake; 12 and 13 - temporary tunnel and water intake.

Figure 3 - Nurek complex components (right bank dowstream)

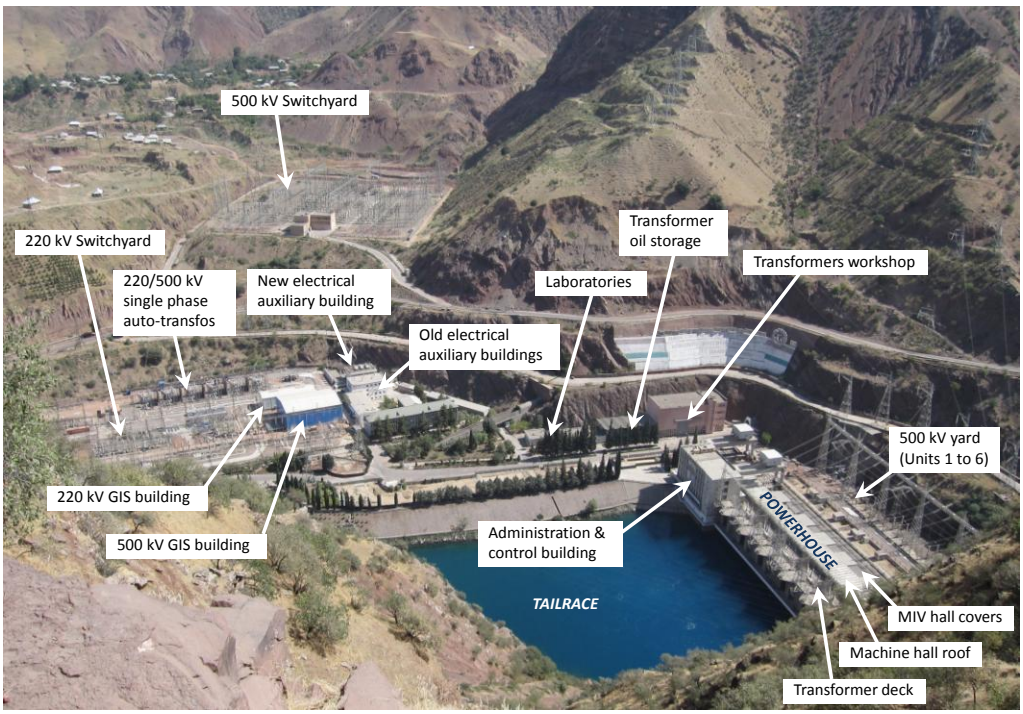
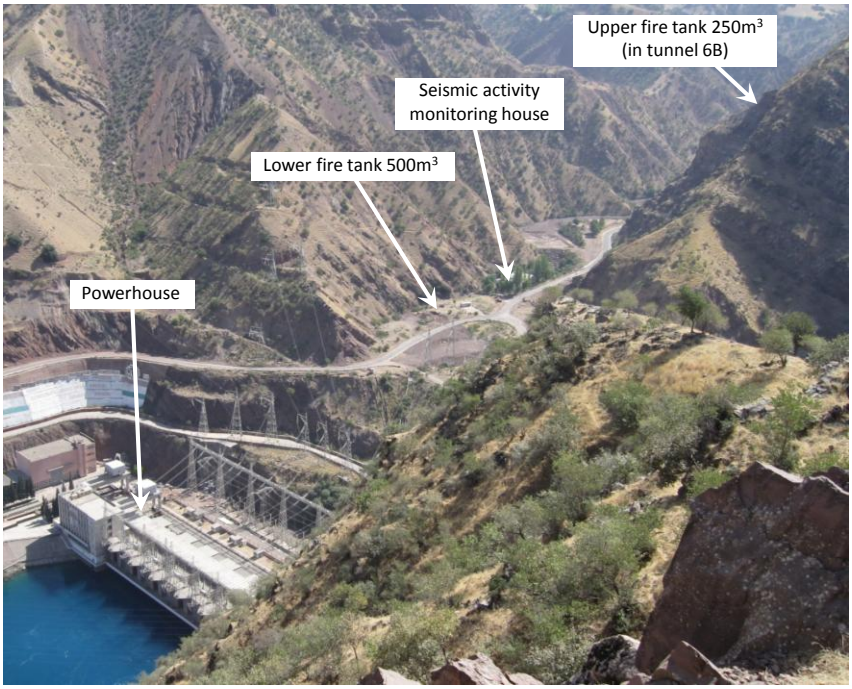


Figure 4 - Nurek complex components (powerhouse and above)



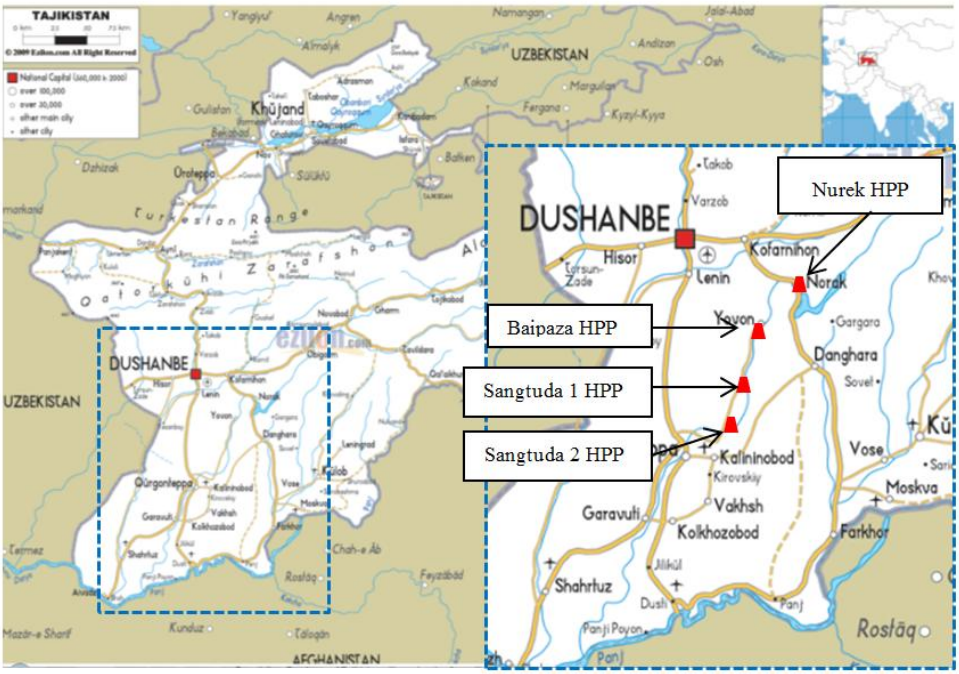
3.1.4. HPP main parameters

- Installed rated capacity : 3000 MW
- Number of units : 9
- Unit Supplier : TURBOATOM (Kharkov)
- Type : Francis
- Rated machine speed : 200 rpm
- Runner Diameter : 4.75 m
- First machine commissioned : 1972
- Last machine commissioned : 1979
- Maximum flow including: : 5,400 m^3/s
  - Two spillways: bottom and surface : 2,200 m^3/sec + 2,020 m^3/s
  - Flow through HPP powerhouse : 1360 m^3/s
- Maximum operating water head : 275 m
- Minimum operating water head : 207 m
- Nominal operating water head : 230 m

Figure 5 - Nurek HPP turbine hall

The main access road to the dam site and powerhouse is the road A385 coming from Dushanbe the capital. Access to the power house is via Lenin Street in Nurek.

Figure 6 – Project location



3.1.5. Current operating rules of Nurek HPP

Source of the data: *Techno-economic assessment study (TEAS) for rehabilitation of Nurek HPP and dam safety provisions – Final Report – Volume II – Chapter 6 "Flood Routing".*

Nurek reservoir management follows the principles described hereafter:

- In winter, the natural inflows of the Vakhsh River are low. Nearly all the active storage is used throughout the winter season to compensate for the low inflows and maximize winter energy generation. This volume is distributed evenly throughout the season to ensure base energy production.
- In summer, the highest natural inflows of the Vakhsh River occur due to the melting of glaciers in the reservoir's catchment area. The reservoir is operated throughout summer with the objective of reaching the reservoir's Full Supply Level before the end of the summer season. An operating rule is in force to limit the rate of filling of the reservoir.

Besides the mentioned operating rule limiting the filling rate, these principles are not formally enclosed in an operating manual. However, they correspond to the own purpose of the Nurek HPP scheme of regulating water from summer to winter in order to ensure a base production of winter energy.

The following paragraphs describe: (a) the existing instructions and directives for operation; and (b) the analysis of the period of exploitation between 2007 and 2014.

a. Instructions - Directives

The Instruction N°922-11-T112 "About Nurek dam exploitation and surveillance of its condition" specifies the maximum speed of reservoir filling. This speed has to be lower than:

- 1 m/day if $H_{Res} < 900.00\ m.a.s.l.$
- 0.5 m/day if $H_{Res} > 900.00\ m.a.s.l.$

Also, it is forbidden to decrease the reservoir level below 857.00 masl and to increase the reservoir level over 910.00 masl.

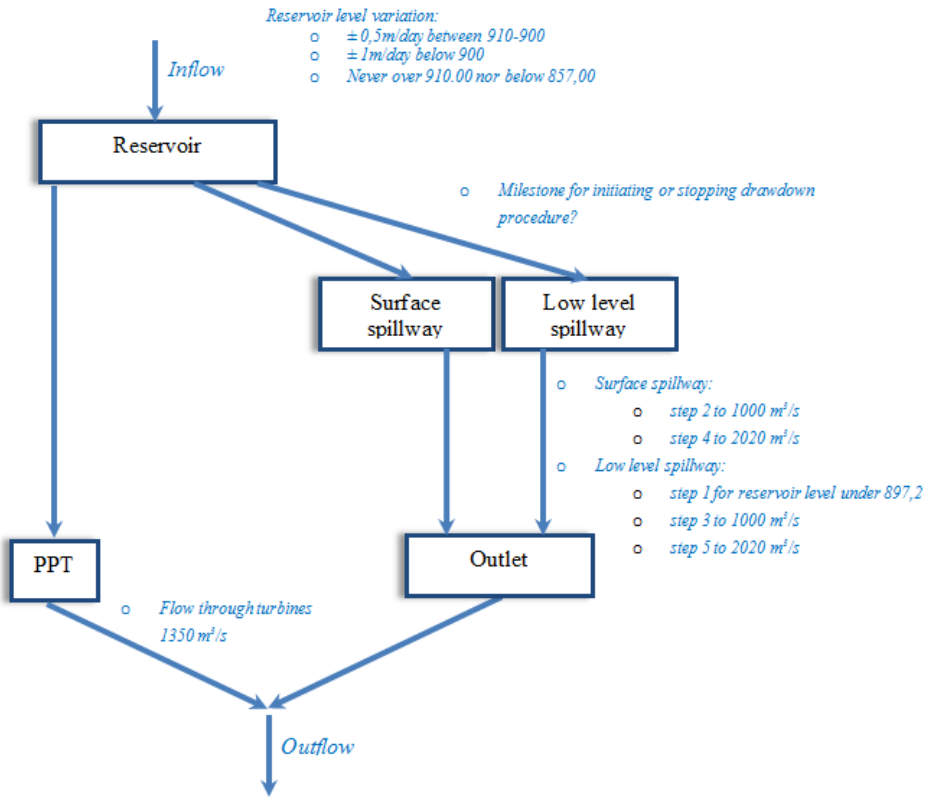
In case of "significant" inflow and if the reservoir level exceeds 897.2 masl (surface spillway sill level) the drawdown procedure is initiated and the spillways are operated in the following order:

1. HPP till a flow in turbines of 1,350 m^3/s;
2. Surface spillway till a flow of 1,000 m^3/s;
3. Low level spillway till a flow of 1,000 m^3/s;
4. Surface spillway till a flow of 2,020 m^3/s;
5. Low level spillway till a flow of 2,020 m^3/s (this value is lower than the capacity of the bottom spillway shown in Figure 7);

When the inflow decreases, the spillways are operated in the opposite order.

The following diagram summarizes flood management in case of "significant" inflow in the reservoir.

Figure 7 - Flood management diagram



(Source: Tractebel Engineering, 2015)

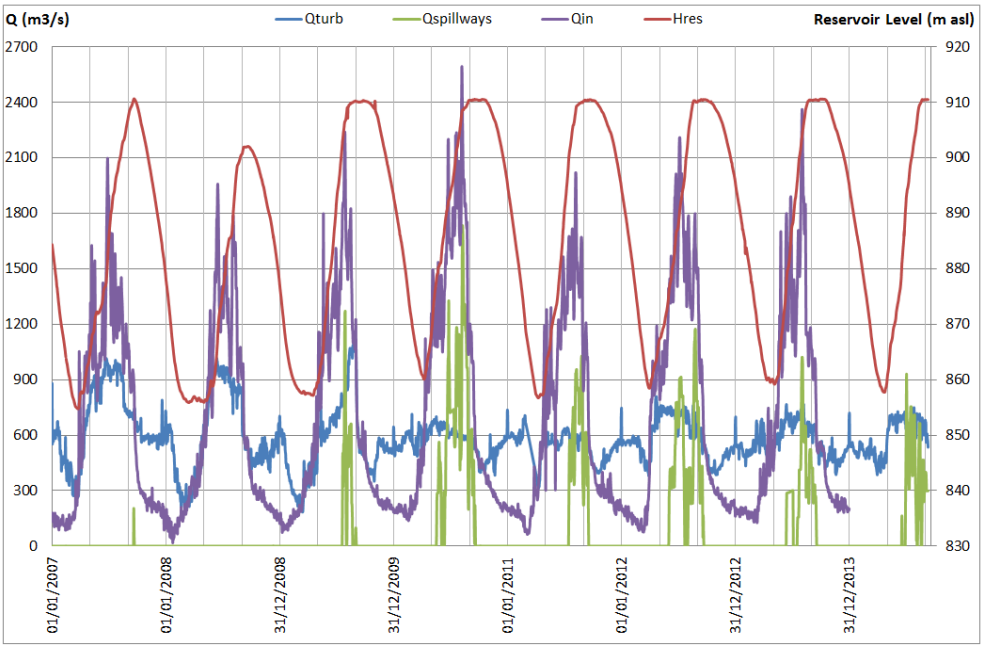
b. Analysis of the period of exploitation between 2007 and 2014

The following figures show the evolution between 2007 and 2014 of the daily flow through the turbines, the total spillways' discharge, the reservoir level and the total outflow discharge (turbines + spillways).

It appears that from the beginning of May to the end of October the minimum value of daily average flow through the turbines ($Q_{turb\ min}$) is 562 m^3/s, the maximum value of daily average flow through the turbines ($Q_{turb\ max}$) is 1,015 m^3/s and the maximum water level ($H_{Res\ max}$) in the reservoir is 910.7 masl. The flow through the turbines is far from the maximum design value of 1,350 m^3/s.

In addition, at the same time that the flow through the turbines decreases after 2009 (no change of average reservoir level), we observe a corresponding increase of the spillage flow. This shows the appropriate reservoir management even if between the end of July and the end of September some periods of exceedance of the full supply level are noticed.

Figure 8- Evolution of the power plant and spillways outflow, of the inflow and of the reservoir level



As can be seen in Figure 8, the maximum daily average inflow recorded since 2007 is 2,590 m^3/s which is close to 3,100 m^3/s (maximal daily average inflow recorded since 1983). This value of 3,100 m^3/s is much lower than the peak value of the 1,000-year flood (4,720 m^3/s). So since its first impounding, Nurek dam has never faced the 1,000-year return period flood.

Figure 9 - Evolution of the total outflow discharge and of the inflow from 2007 to 2014

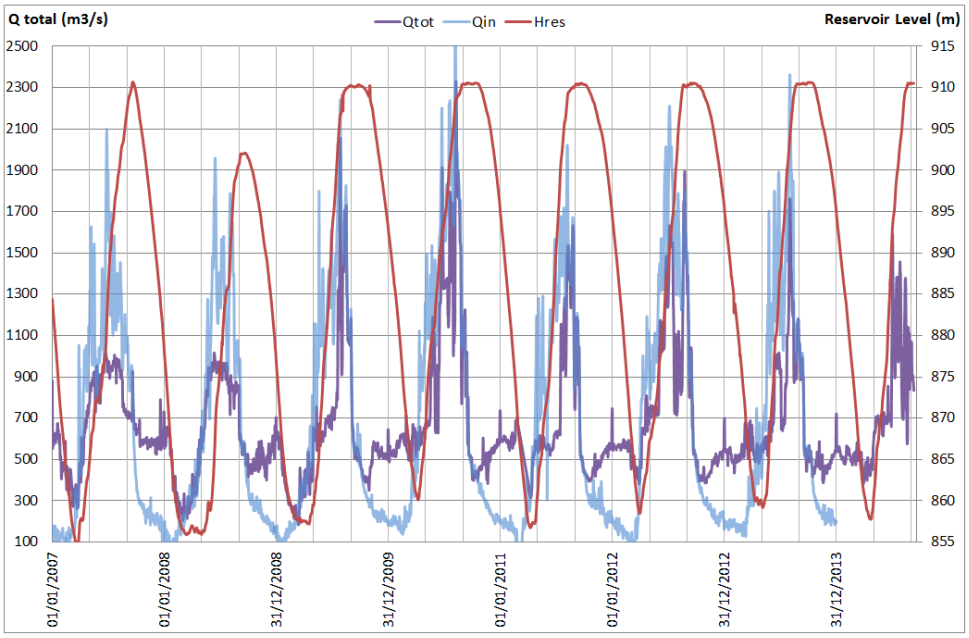
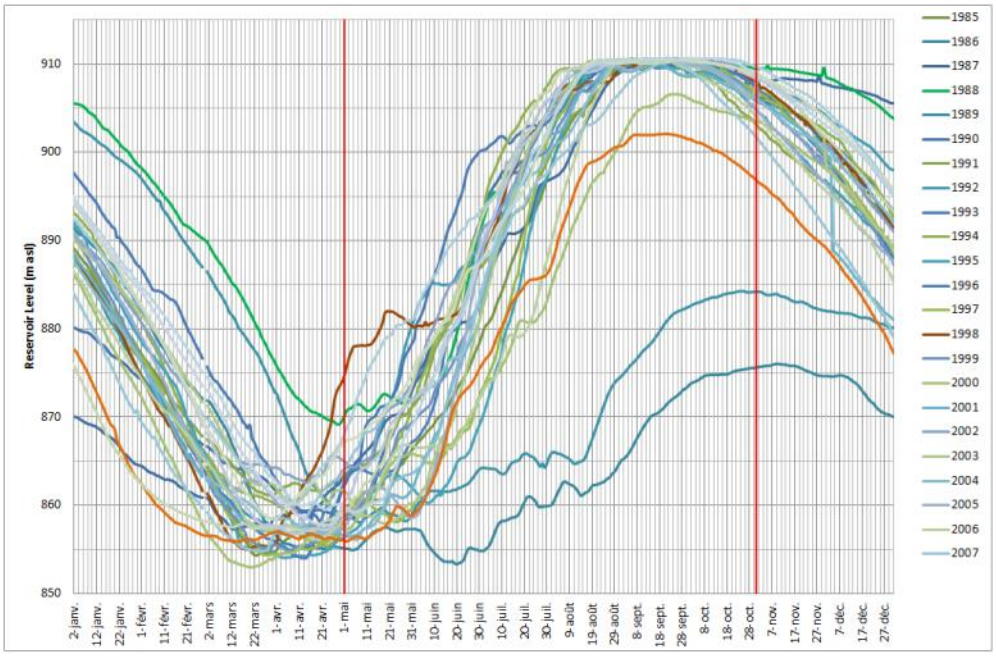
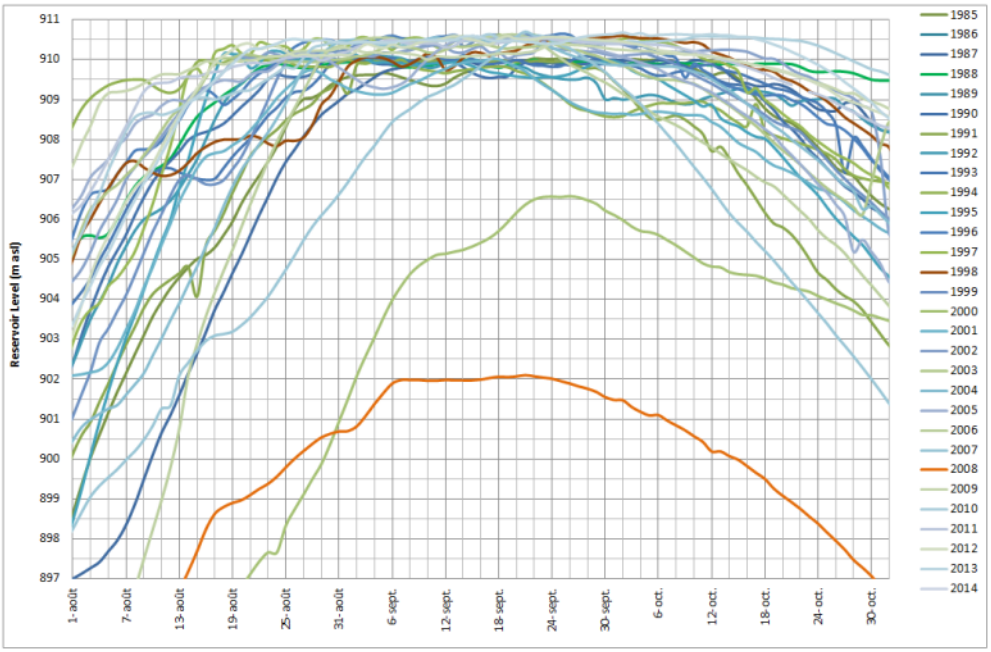


Figure 10- Evolution of the reservoir level during the period 2007 - 2014



The following figure shows that from mid-August to the end of October the reservoir level usually exceeds the full supply level (FSL).

Figure 11 - Focus when the reservoir level exceeds the FSL over the 2007-2014 period



The following table shows the time during which the reservoir level exceeded the FSL from the end of the first impounding (1983). To underline significant exceedance, only values above 910.1 masl are considered.

Table 4 - Duration of exceedance of the FSL

Year	Number of days over 910.10 masl	Year	Number of days over 910.10 masl
1983 - 1985	0	2000	0
1986	0	2001	0
1987	0	2002	46
1988	0	2003	29
1989	0	2004	29
1990	0	2005	24
1991	0	2006	26
1992	2	2007	10
1993	0	2008	0
1994	0	2009	53
1995	12	2010	60
1996	44	2011	49
1997	45	2012	58
1998	29	2013	64
1999	40	2014	34

Since 1995, the average annual duration of this exceeding of the FSL is 33 days/year (9% of the time).

As can be observed the reservoir level frequently exceeds the full supply level 910 masl, and falls below the minimum operating operation level 857 masl.

The evolution of the speed of reservoir filling between 2007 and 2014 is shown in the following figures:

Figure 12 - Reservoir filling speed - beginning of year

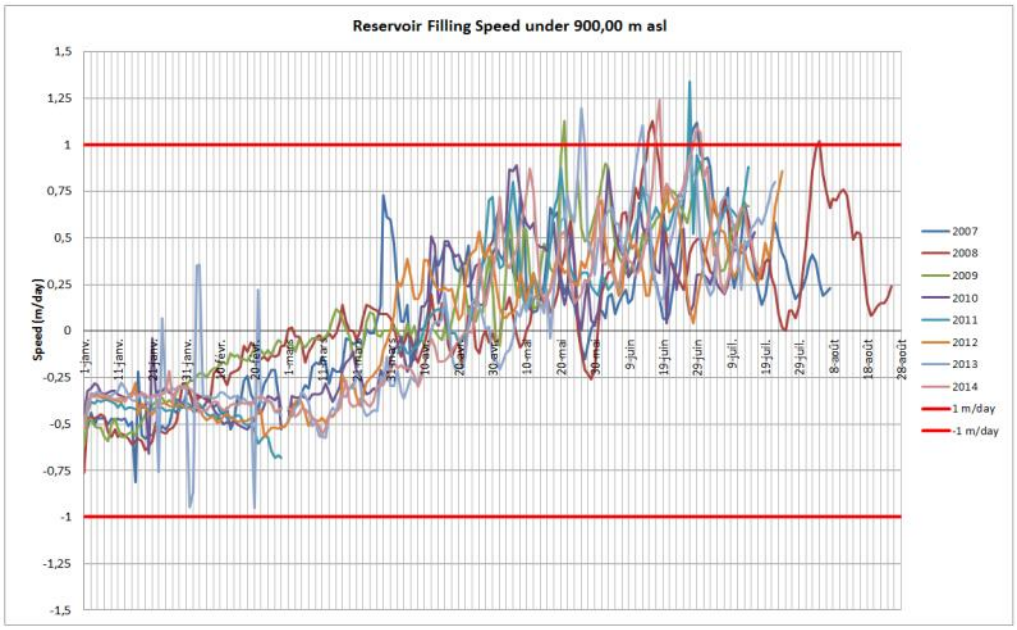


Figure 13 - Reservoir filling speed - middle of year

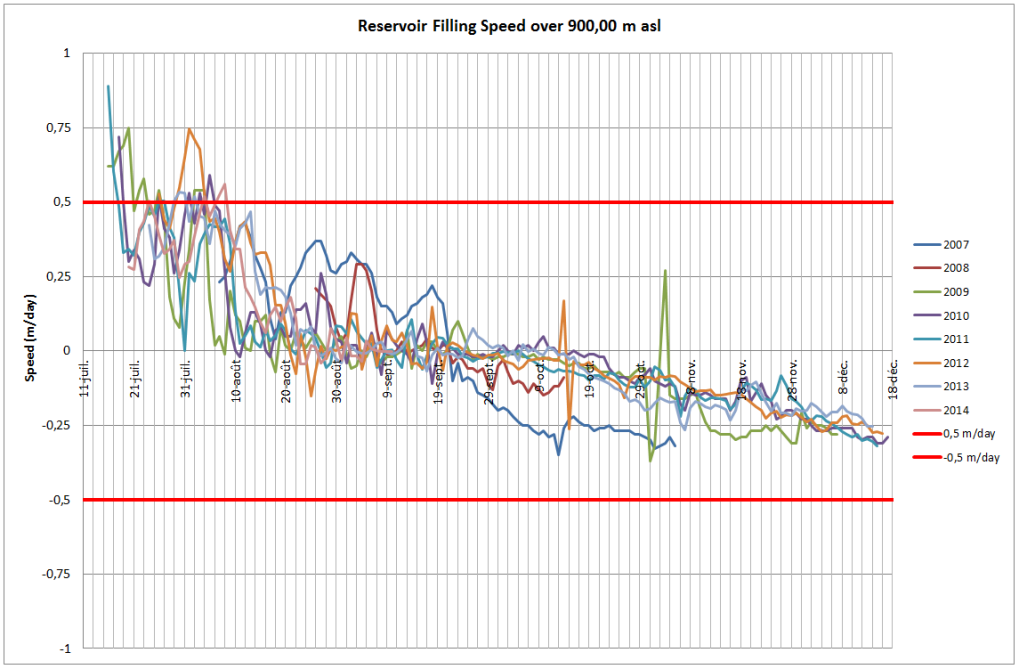
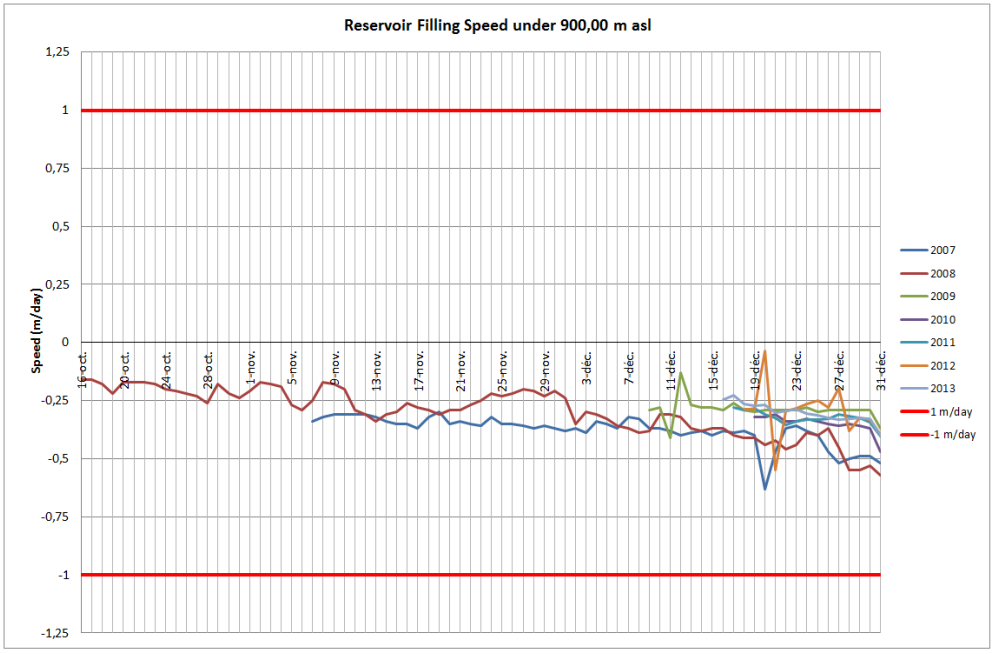


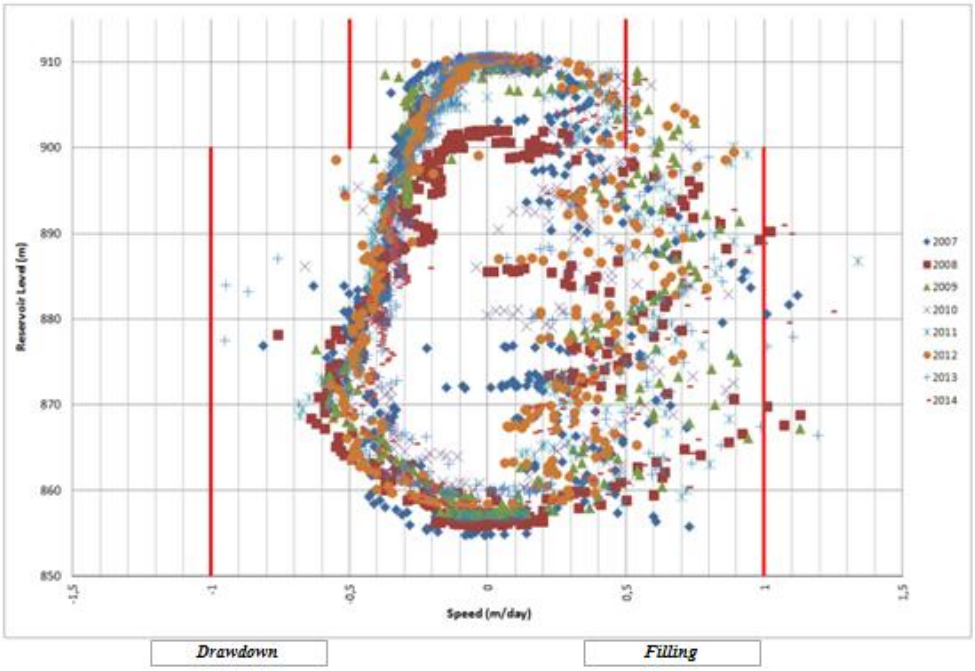
Figure 14 - Reservoir filling speed - end of year



There are isolated events of the reservoir filling speed exceeding the stated limits but the general trend confirms a good respect of the operation rule that stipulates speed limits of reservoir level variations (1 m/day under 900.00 masl and 0.5 m/day over 900.00 masl).

The following figure is another representation of the respect of this criterion.

Figure 15 - Reservoir level versus filling speed



3.1.6. Energy production

Nurek HPP currently has an installed capacity of 3,000 MW. However, in recent years of operation the units have faced issues of vibrations and/or temperature alarms, which require the capacity of some units to be reduced. Due to these issues, the maximum capacity of the plant is estimated at 2,320 MW. The Unit 8 is out of service, and the total capacity reduction of the other turbines is the equivalent maximum capacity of one unit. Therefore, the equivalent of 2 units is currently out of order.

Note: Unit no. 8 has been out of service since 2011. Repairs have been carried out on the turbine, but during the restart the transformer connected to the unit failed. A new transformer must be installed very soon in order to overcome this problem, but the refurbishment project will also take care of this unit, so that all the new equipment is homogeneous.

The current limitations of the units are detailed in the following table:

Table 5 - Current limitation and capacity of the ninth units

Unit	Installed capacity	Limitation due to	Minimum power	Maximum power
U1	335	Vibration and generator temperature	60	270
U2	335	Vibration	135	270
U3	335	Generator temperature	35	300
U4	335	Generator temperature	35	300
U5	320	Vibration and temperature	40	280
U6	335	Vibration and temperature	35	300
U7	335	Vibration and temperature	35	300
U8	335	-	0	0
U9	335	Vibration and temperature	35	300
			Total available capacity	**2,320 MW**

Records of generation of Nurek HPP over the period 2007-2013 show a yearly production of 10,700 GWh/year on average composed of 4,550 GWh of average winter production and 6,150 GWh of average summer production.

The results of the energy generation simulations (see Volume I Chapter 3) actually show that summer production has been limited by the lack of load on the network (i.e. lack of energy demand). Indeed, considering the current limitation of 2,320 MW but not considering any network load limitation, the simulations show that 11,320 GWh could have been produced on average per annum, composed of 4,669 GWh of average winter production and 6,651 GWh of average summer production.

This situation is shown in the following graphs comparing yearly productions over the 2007-2013 period between historic records and simulations:

Figure 16 - Average Winter energy values from 2007 to 2013 – 2,320 MW

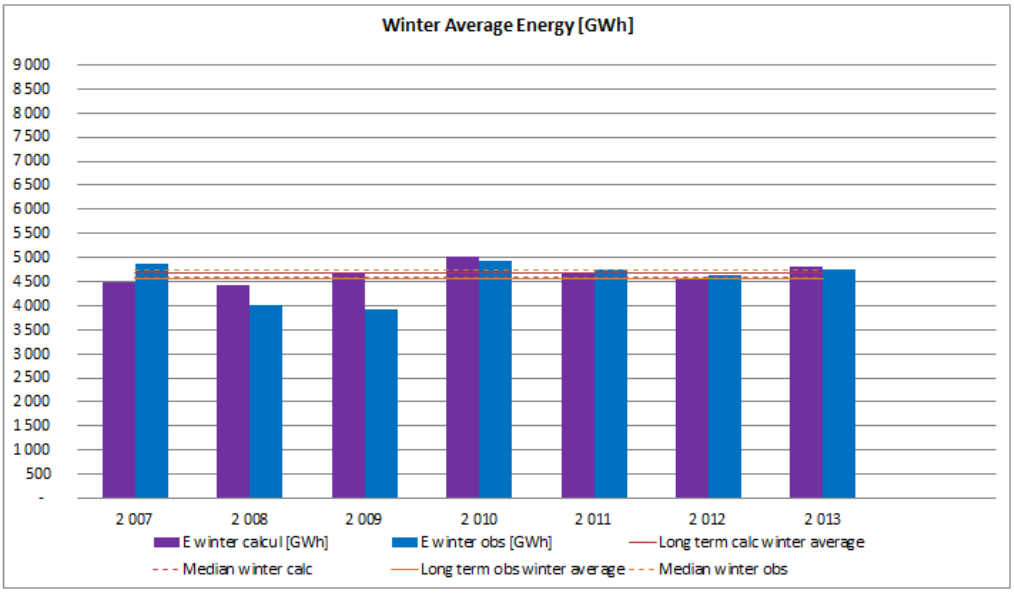
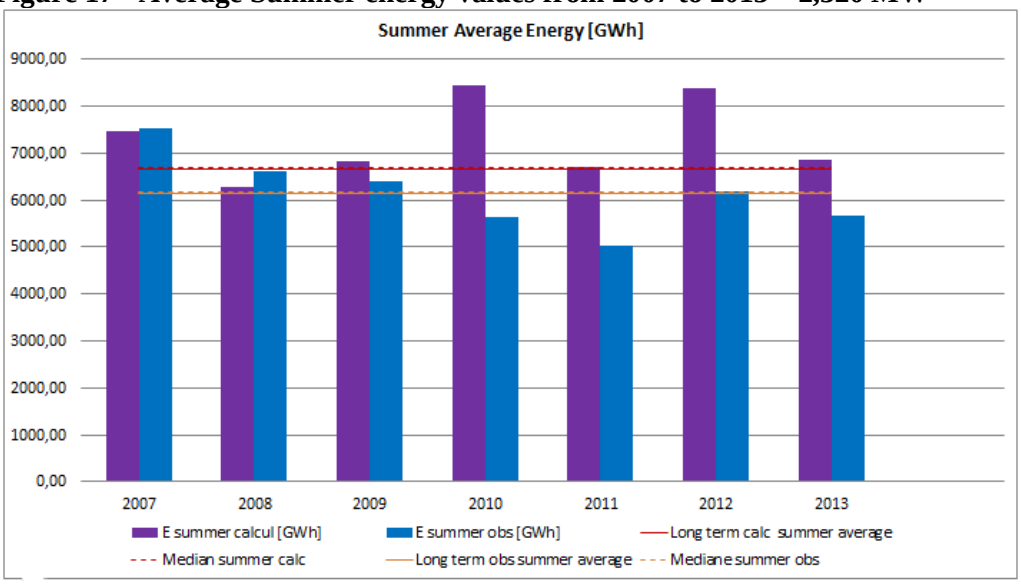


Figure 17 - Average Summer energy values from 2007 to 2013 – 2,320 MW



3.2. The project

3.2.1. General description: situation, context and objectives

Nurek HPP is Tajikistan's main source of energy. From 1992 up to 2005, the Nurek HPP generated about 70% of the electricity in Tajikistan's power grid. In 1991, the installed capacity of the HPP was increased from 2,700 MW to 3,000 MW. The capacity of all turbines except 5 had already been increased in 1989 to 335 MW with a head of 230 m. Nevertheless, due to vibrations and overheating of the units, the upper limit output recorded was not higher than 2,320 MW.

Reduction of Nurek HPP's storage capacity due to sediment accumulation is another issue to be taken into account about capacity reduction.

The purpose of the project is multiple:

(iv) Restore the generation capacity of Nurek HPP through refurbishment of the generating units and the balance of the plant;
(v) Increase efficiency of the generating units through improved hydraulic design and installation of higher efficiency equipment; and
(vi) Enhance the safety of the Nurek dam through rrehabilitation of spillway tunnels, refurbishment of spillway gates/hoisting system, improvement of protection on permeable zone of the embankment dam above the core zone crest, measures to enhance safety against seism and hydrological risks.

3.2.2. The project

The project will include rehabilitation of generating units of Nurek HPP. Furthermore, the project considers a 4-12% increase of the installed capacity. The bidders will have flexibility to propose increased rated capacity.

The main project components are presented below:

- Component 1: Rehabilitation of the power plant and auto-transformers (US$310 million). This component will consist of two sub-components.
  - *Sub-component 1.1: Replacement and refurbishment of mechanical, electrical, and electromechanical equipment and works required for the rehabilitation of the Nurek HPP* (US$270 million). This sub-component will finance: (a) rehabilitation of three power generating units (generators, turbines, main inlet valves, transformers), auxiliary systems and key balance of plant; and (b) Providing spare parts, and operations and maintenance equipment.
  - *Sub-component 1.2: Replacement of auto-transformers* (US$40 million). This sub-component will finance the supply and installation of six auto-transformers, replacing the existing aged auto-transformers.

- Component 2: Dam Safety (US$30 million). This component will finance activities to improve the safety of the operation of the Nurek HPP. The scope will be finalized during the appraisal based on the results of ongoing studies and would include the following activities, among others: (a) works and equipment to improve dam safety, such as rehabilitation of spillway tunnels, refurbishing spillway gates/hoisting system, enhancing the effective height of the impervious zone by utilizing an existing concrete gallery above the dam core, rehabilitation of the seismic belt to enhance resistance to earthquakes, etc.; (b) refurbishment and upgrade of monitoring instruments and management system to improve the collection and analysis of the safety monitoring data; (c) update of the Emergency Preparedness Plan, Operation and Maintenance Plan, and the Instrumentation Plan; (d) introduction of an advanced flood forecasting/warning system and preparing optimized reservoir operating rules to enhance the flood-handling capacity of the dam.

- Component 3: Technical Assistance (US$10 million). This component will support implementation of the Project and strengthen the institutional capacity of BT by supporting the following: (a) Panel of Experts (POE) on matters related to dam safety and other critical aspects of the Project; (b) project management consultant (PMC) to assist with the design, bidding, quality control and construction supervision of the project; (c) consultant services to support BT with citizen engagement and gender-informed consultative processes during project implementation; (d) capacity building for Nurek HPP and BT staff, including in project management, dam safety, operation and management of hydro facilities, fiduciary and safeguards aspects of the Project; (e) advisory and analytical support aimed at improvement of BT's financial standing.

As the sub-component 1.1 – *Replacement and refurbishment of mechanical, electrical, and electromechanical equipment and works required for the rehabilitation of the Nurek HPP* is expected to have more impact than any other part of the project, this ESIA focuses on it.

3.2.3. Refurbishment project work schedule

As a base case scenario, it is considered that each unit will be taken out of service one after the other for rehabilitation. In this case, the project will be implemented over a period of 10 years.

The rehabilitation of the Nurek HPP will be carried out in two phases. The first phase is expected to comprise the rehabilitation of three generating units, some of the balance of plant rehabilitation and critical dam safety works. The remaining six units and the remaining balance of plant will be rehabilitated in the second phase of the project.

The first phase, including modeling, design, manufacturing, and installation of the generating units, is scheduled to last 6 years. The site mobilization will take 3 months. The site activities will last between 10 and 11 months per unit (between the dismantling task and the finalization of the test task). Each turbine and generator will be stopped, dismantled, rehabilitated and reinstalled.

Only one turbine will be stopped at a time, but the procurement and transport phase of a turbine will start during the dismantling and installation phase of the previous one. This is in order to be ready to start the dismantling of the following turbine when the refurbishment is completed on the previous one.

The detailed schedule is available in Appendix 2.

An alternative scenario was envisaged where up to two units can be taken out of service at the same time for rehabilitation in order to reduce the project duration. In this alternative, the project would be implemented over a period of 7 years and 7 months. However this alternative was rejected by Tajik Authorities as it introduces limitations in electricity production and difficulties in regular maintenance of the units during the course of the Project.

3.2.4. Methodology/process

The refurbishment process contains 13 main tasks.

3.2.4.1. PROJECT PREPARATION AND MOBILIZATION

- **Task 01: Turbine hydraulic model test**
- **Task 02: Project design.**

This task will consist of 4 sub-tasks:

- Task 02.1: Main Turbine components design
- Task 02.2: Main Generator components design
- Task 02.3: BOP equipment
- Task 02.4: Control system equipment

- **Task 03: Mobilization at site**

This task will consist of workers and equipment mobilization.

3.2.4.2. REFURBISHMENT TASKS

All the following tasks and sub-tasks will be repeated for each of the nine units.

- **Task 04: Purchase and transport of Turbine main components**
  - Task 04.1: Runner purchase and transport
  - Task 04.2: Head cover purchase and transport
  - Task 04.3: Guide vane and operating mechanism purchase and transport
  - Task 04.4: Shaft Seal and bearing purchase and transport
- **Task 05: Purchase and transport of Generator main components**
  - Task 05.1: Stator Frame purchase and transport
  - Task 05.2: Stator bars and lamination sheet purchase and transport
  - Task 05.3: Generator shaft brackets and bearing purchase and transport
- **Task 06: Turbine dismantling works**
  - Task 06.1: Preparation works
  - Task 06.2: Distributor dismantling
  - Task 06.3: Bearing and shaft seal dismantling
  - Task 06.4: Head Cover dismantling / Runner / Guide Vanes out
- **Task 07: Generator dismantling works**
  - Task 07.1: Preparation works

- Task 07.2: Upper Guide and Thrust bearing dismantling
- Task 07.3: Lower bearing dismantling and rotor lifting
- Task 07.4: Stator dismantling

- **Task 08: Generator components - Rehabilitation works**
  - Task 08.1: Stator frame preparation
  - Task 08.2: Other components rehabilitation
- **Task 09: Turbine components - Rehabilitation works**
  - Task 09.1: SC & stay vanes inspection / painting / rehabilitation
  - Task 09.2: Bottom ring inspection / painting / rehabilitation
  - Task 09.3: Guide vane refurbishment
- **Task 10: Generator Installation**
  - Task 10.1: Stator frame installation & preparation work to stacking
  - Task 10.2: Stator stacking & magnetization test
  - Task 10.3: Stator winding
  - Task 10.4: Electrical test
  - Task 10.5: Rotor lowering and air gap checking
  - Task 10.6: Lower bearing installation
  - Task 10.7: Upper guide bearing and thrust bearing
  - Task 10.8: End of instrumentation, cabling, piping & wiring
- **Task 11: Turbine Installation**
  - Task 11.1: Bottom ring / Head Cover adjustment
  - Task 11.2: Runner & shaft lowering and adjustment
  - Task 11.3: Distributor components in the pit
  - Task 11.4: Distributor adjustment
  - Task 11.5: Bearing & shaft seal installation
  - Task 11.6: End of instrumentation, cabling, piping & wiring
- **Task 12: Turbine + Generator test**
  - Task 12.1: Shafts coupling and shaft line checking
  - Task 12.2: Bearing gap adjustment & checking
  - Task 12.3: Commissioning - Dry test
  - Task 12.4: Commissioning - Wet test
  - Task 12.5: Trial operation test
- **Task 13: Unforeseeable Conditions**

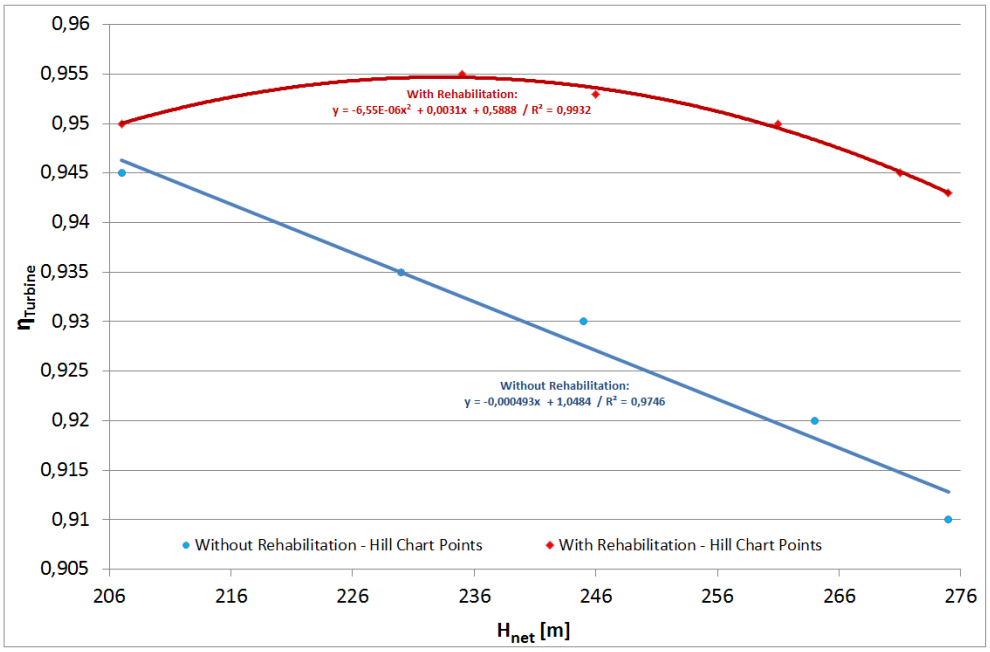
3.2.5. Refurbishment project result

As presented earlier in the report, the generator rated capacity was upgraded in 1988, which ensured a total installed capacity of 3,000 MW. Nevertheless, in recent years, the upper limit output recorded was not higher than 2,320 MW.

The refurbishment will thus lead to the increase of hydro-electromechanical performances and the recovering of the full installed capacity.

The following figure presents the maximal turbine efficiency (η_{turbine}) assumed in the calculation of turbine efficiency (that is simplified on varying only with the net head) with and without rehabilitation.

Figure 18 - Turbine efficiency curves



As it can be seen, the project will increase the efficiency of the powerhouse.

By replacing certain components, the project will extend the operation life of the facilities.

3.2.6. Dam safety evaluation

Within the World Bank policy OP 4.3 "Safety of dams", a safety analysis is required.

This is justified by the fact that this project relies on the performance and capacity of an existing dam.

In this context, the Bank requires that the borrower (a) inspect and evaluate the safety status of the existing dam, its appurtenances, and its performance history; (b) review and evaluate the owner's operation and maintenance procedures; and (c) provide a written report of findings and recommendations for any remedial work or safety-related measures necessary to upgrade the existing dam to an acceptable standard of safety.

The dam safety analysis carried out in the frame of the study is presented in Volume II.

In outcome of the dam safety analysis, recommendations have been issued. The detailed list has been including in Appendix 1 . The recommendations are classified into different topics:

- Technical documentation;
- Organization of the surveillance;
- Electricity supply of dam, water intake and spillways;
- Hydro-electromechanical equipment of dam tunnels;
- Monitoring instruments;

- Monitoring measurements;
- Visual observations;
- Investigations and surveys;
- Engineering studies;
- Reservoir operation;
- Works and Access and security of staff.

4. BASELINE DATA

The relevant aspects of the environment, with its three main components: physical, biological and human environment, are described. Each of these Chapters contains the following sections:

- **General background**: describes the subject and scope of the chapter regarding the effect usually expected in relation with refurbishment of dam projects.
- **Baseline**: describes the prevailing situation of the environment.
- **Conclusion**: underlines the main general characteristic of the studied environmental component and summarizes the main issues that the project will face.

This basic structure may vary depending on the subject, its importance and complexity.

The Nurek HPP, commissioned in 1972, must have had some significant impacts on the environment that prevailed before its construction. Nevertheless, the purpose of this ESIA is to address the impacts of the project, and not those of the current dam; the dam is therefore considered as a baseline component.

4.1. Project area of influence: study areas

As for a hydropower project, a refurbishment project, due to transport, replacement of turbines and the schedule of these operations, can influence different areas in different ways. Thus, for the purpose of this EIA, the study area had to be divided into several specific areas. All the study areas do not require the same level of detail. These areas are:

4.1.1. SA01: Nurek HPP and appurtenant structures

This is the main project area. This area had to be considered to a higher level of detail.

4.1.2. SA02: Access road

The transport of components (turbine, etc.) along the access roads can have impacts on the socio-environmental context.

The option currently used by the project and analyzed here is the use of existing access road. This access road starts from Dushanbe and passes through a couple of towns and villages before arriving in Nurek city. Thus, it does not require the construction of any new access roads.

Another possibility, mentioned during the first round of consultations, would be to rehabilitate a bridge in order to use a road passing outside the city, thus reducing nuisance, especially by passing trucks. But this option requires a specific techno-economic study in order to know if it is realistic (the bridge seems to have to be completely rebuilt, cf. Figure 19). If appropriate, this study may be included in the scope of the EPC Contractor.

Figure 19 - View of bridge in Nurek HPP area, proposed for use as alternative route

4.1.3. SA03: Downstream area

During the replacement of turbines, the main impacts on the downstream area including floodplain habitats are: (1) the risk of modification of the hydrological regime; and (2) the water pollution and its potential impacts on water users in the downstream area.

For Nurek HPP, the downstream area can be divided into 2 parts:

- Vakhsh River downstream of Nurek HPP until the confluence with Pyanj River (forming the Amu Darya). In this section, the project could cause cumulative impacts on the hydropower cascade, modification of water flow for irrigation, and affect floodplain habitats;
- Amu Darya Basin between Vakhsh and Pyanj River confluence and until the Aral Sea. In this section water flow modification could cause affect riparian countries.

4.1.4. SA04: Upstream area

The upstream reservoir area could be affected by the Project insofar as changes in the reservoir level could occur. The water inflow and outflow of the reservoir will therefore be studied.

4.2. Physical environment

4.2.1. Hydrology

a. General

Hydrology is a central issue of the study. The objective of this chapter is to identify and characterize the main issues related to water in terms of quantity and quality, in the perspective of Nurek HPP refurbishment project.

In a hydropower plant refurbishment, attention should be paid to the changes that the project could introduce in the operation of the plant, whether during the period of refurbishment works or once the Project is completed. Such changes could affect the upstream reservoir area (if modifying usual reservoir levels) and the downstream area (if changing the water discharge patterns).

The hydrological assessment of this chapter presents a description of the Vakhsh River upstream and downstream of Nurek HPP.

b. Baseline

The Amu Darya is the largest river of Central Asia, and one of the two main tributaries of the Aral Sea. The river is formed by the confluence of its two most important tributaries, the Pyanj and Vakhsh Rivers. The Vakhsh contributes an average of about 26% of the annual flow of the Amu Darya, and the Pyanj about 40%. In the Amu Darya as in the Vakhsh, the flow pattern is highly seasonal, with high flows in summer due to snow and glacier melt in the mountains, and low flows in winter since most of the precipitation in the catchment area falls as snow.

For this Chapter, historical data have been used. Historical records of the reservoir's operation have been made available by Nurek HPP:

- Daily inflows to the reservoir between 1972 and 2013;
- Daily turbined flow between 2007 and 2013;
- Daily discharges by the spillways between 2007 and 2013;
- Daily reservoir and tail water levels between 1972 and 2013;
- Daily produced power and energy between 1972 and 2013;
- Turbine hill charts.

Downstream: hydrology with Nurek HPP in operation

Downstream of Nurek HPP, the total outflow (turbine + spillways) is represented in the following table and figures.

Figure 20 - Total daily discharge outflow 1972-2013 (m^3/s)

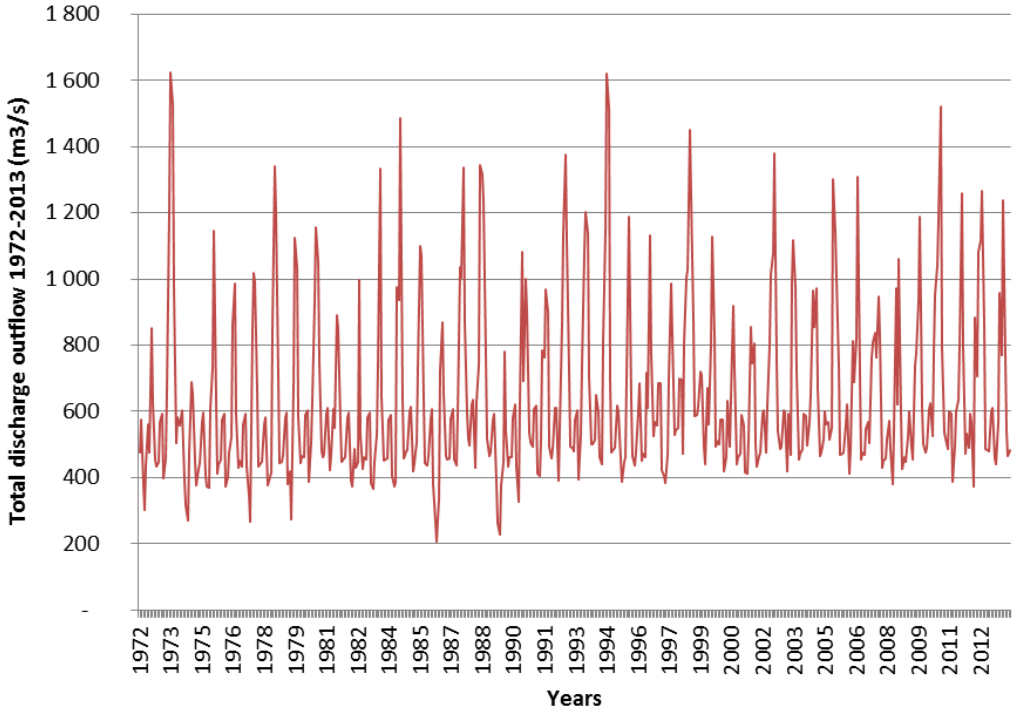
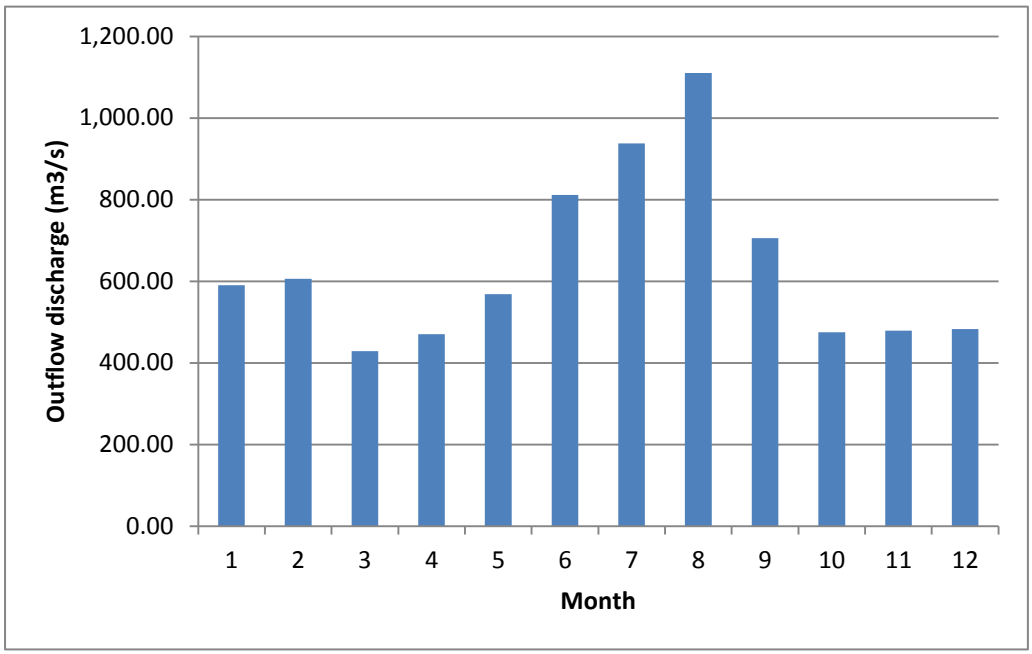


Table 6 - Total monthly outflow average discharge 2007-2013 (m^3/s)

Jan.	Feb.	March	April	May	June	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
590.16	606.04	428.88	470.20	568.62	811.47	937.92	1,110.46	705.84	475.28	479.25	482.83

Figure 21 - Total monthly outflow average discharge 2007-2013 (m^3/s)



Upstream: Nurek HPP reservoir characteristics in operation

The Vakhsh River flow upstream Nurek HPP has been analyzed with the daily inflow for the period 1972-2013 (available data).

The following figure presents the daily inflow to the Nurek reservoir since 1972.

Figure 22 - Daily inflow in the reservoir between 1972 and 2013

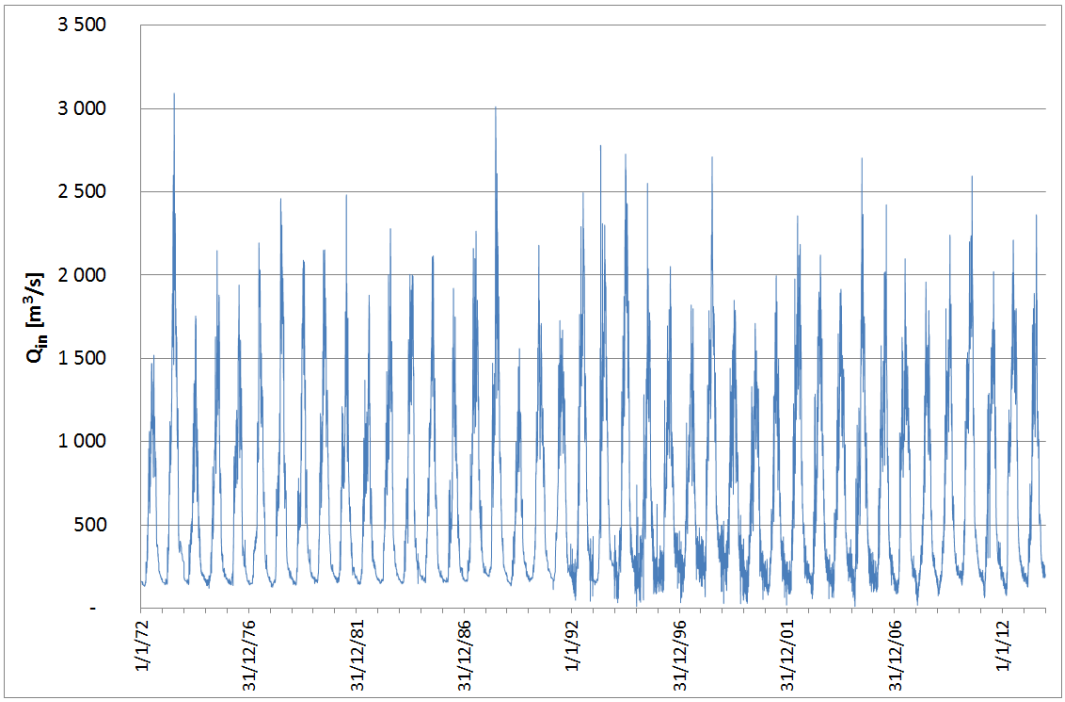
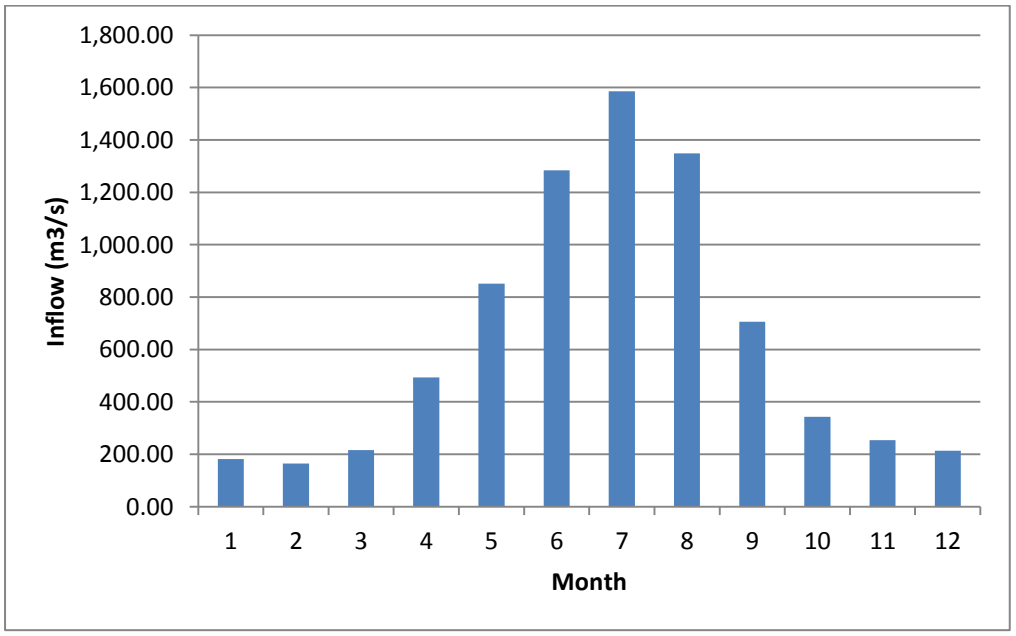


Table 7 - Monthly average inflow in the reservoir (m^3/s)

Jan.	Feb.	March	April	May	June	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
181.28	164.78	215.41	492.76	851.39	1,283.75	1,585.25	1,348.57	706.44	343.22	253.71	213.79

Figure 23 - Monthly average inflow in the reservoir (m^3/s)

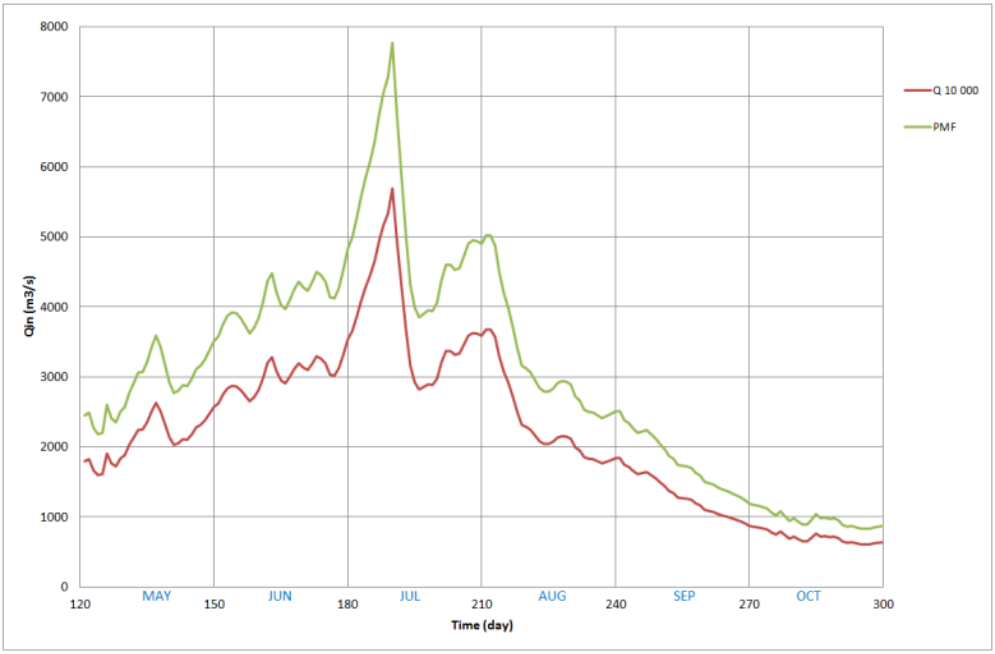


Flooding

The peak inflow values for the corresponding to the 10,000 year flood and the Probable Maximum Flood (PMF) have been evaluated[5] as 5,690 m^3/s and 7,770 m^3/s respectively.

The hydrographs of these floods are shown in Figure 24 below. The most important inflows in the Nurek reservoir occur between May and September.

Figure 24 - Floods in Nurek reservoir with return periods of 10,000 year and PMF



The reservoir volume at the 920 m water level is 9.65 billion cubic meters. Based on the flood hydrographs in Figure 24, the total flood volumes of the PMF and the 10,000 year return flood are evaluated at 46.8 billion cubic meters and 34.3 billion cubic meters respectively. Therefore, the two mentioned floods can generate water inflow volumes 3.5 to 4.8 times the reservoir volume.

4.2.2. Water Quality

a. Within the Amu Darya basin

The quality of drinking water in many populated parts of the Amu Darya is deteriorating, particularly downstream of Nurek where it is causing a rise in kidney, thyroid and liver diseases and preventing iron absorption, leading to anemia[6].

The Amu Darya River in its lower reach is characterized by a degradation of its quality mainly related to salinity (sulphates, chlorine, sodium and potassium).

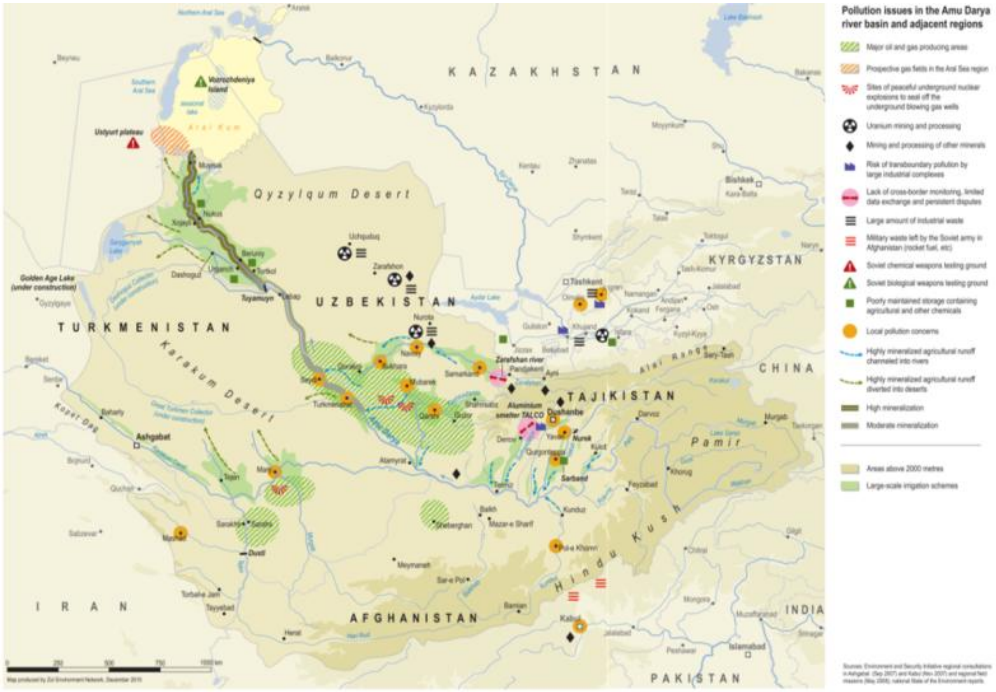
[5] Database system implementation at Nurek Dam, IH NURE COND 00021 A BPE, EDF, 2007

[6] According to FAO "studies show that of the 700'000 women in Karakalpakstan, more 90 per cent are anaemic with haemoglobin levels in their blood well below the World Health Organization's standards and probably with the highest rates in the world (source www.fao.org/news/1997/970104-e.htm)

Between 1960 and 1989, the average salinity of the Amu-Darya's increased from 540 mg/l to 1,161.2 mg/l, with 856.6 mg/l measured in 1990 (L.P. Pavlovskaya)[7]. The situation has not improved since.

Mineralization levels increase downstream of the Vakhsh and Pyanj confluence. Mineralization levels are also fluctuating depending on the season: levels decrease with the spring-summer increase of river flow.

Figure 25 - Pollution issues in the Amu Darya river basin and adjacent regions



(Source: Environment and Security Initiative (ENVSEC), 2011)

The longitudinal increase in deoxygenating pollutants can be mainly considered as indicative of the loss of organic matter from the irrigated areas, which, in conjunction with salinization, contributes to the major degradation processes affecting the land resources surrounding the Amu Darya River.

The major factor impairing water use in the lower part of the river can thus be attributed to the secondary salinization processes originating from the lithological composition of the watershed and which are driven and increased by the irrigation return flows. Major pollution sources are collector-drainage (irrigation runoff) waters from irrigated fields in the mid and downstream reaches of the Amu Darya. In addition to regular irrigation in summer months, the practice of washing agricultural soil in winter considerably increases the salinity of return water, and consequently further compromises river quality, making water flowing in the delta region unsafe for drinking. As a result the regions located in the Amu Darya delta are affected by both the river's failure to reach the Aral Sea and by the high level of pollution in the water that does actually reach the area.

[7] Fishery in the lower Amu-Darya under the impact of irrigated agriculture, L.P. Pavlovskaya

b. Along the Vakhsh river

- **Upstream of Nurek HPP**

The data of this chapter comes from the Environmental impact study of Rogun HPP (Pöyry, 2014), based on the hydrological station of Nurobod located in the future Rogun reservoir, and focuses on the downstream area of Nurek HPP. In this project, with regards to water quality and sedimentation, the reservoir is considered as unchanged.

Like most rivers of Amu Darya basin, the Vakhsh river in Nurobod has a rather high carbonate concentration ($[HCO_3^-]$ = 105 mg/l). The concentration of sulphate regularly exceeds the Tajik requirements for surface water and the concentration of chlorine is rather high, which all together indicates corrosive water.

Table 8 - Water quality of Vakhsh and Amu Darya rivers

Parameter	unit	Vakhsh Nurobod 1998-2010 average	Amu Darya Termez 1996-2001 average	Amu Darya Samanbay 1996-2001 average	Tajikistan requirement for surface water
O2	mg/l		10.5	10.8	4.0 in winter 6.0 in summer
	%sat		99.7	98.7	
BOD	mg/l	-	0.8	1.4	3.0
COD	mg/l	0.6	4.5	15.1	
salinity	mg/l		551.4	1170.0	
pH		7.6	7.6	7.6	
PO_4^{3-}	mg/l	0.06	0.75	0.60	
NO_3^-	mg/l	1.6	0.6	0.5	40
HCO_3^-	mg/l	105.4	131.1	142.9	
Cl-	mg/l	85.4	73.3	213.9	300
$SO4^{2-}$	mg/l	169.6	176.6	433.6	100
Temp.	°C	7.6	16.7	13.6	

Source: for Vakhsh river, TajGidromet, for Amu Darya, Crosa et al., 2006

Only two heavy metals are being monitored in Nurobod: Chromium (Cr VI) and Lead (Pb). Both show concentrations which are close to the normative limits. These high concentrations most probably result from the geochemical characteristics of the catchment rocks, and the intensive erosion processes. The Lead concentrations reported in the following table are those measured in 1980-2010.

Table 9 - Chrome and lead concentration for Vakhsh River in Nurobod

Station	average annual concentration	maximum annual concentration	EU Directive 75/440/EEC (surface water intended for drinking water production)	Tajikistan requirement for surface water
Cr VI (mg/l)	0.017	0.031	0.050	0.100
Pb (mg/l)	0.025	0.030	0.050	0.100

Source: for Vakhsh river, TajGidromet, for Amu Darya, Crosa et al., 2006
Values for 1980-2010

As in the Amu Darya, the Vakhsh river water is characterized by a degradation of its quality mainly related to salinity.

Regarding sediments loads, due to the intensity of erosion processes in its catchment, the Vakhsh River is characterized by a high sediment load. The concentration of suspended solids fluctuates during the year and reaches its maximum during the flood season. Per unit water discharge, sediment concentrations are higher during the flood increasing period than during the flood decreasing period.

Due to the Nurek HPP, the majority of the sediments of the upper Vakhsh catchment no longer reaches the lower catchment but instead is deposited in the Nurek reservoir. Various estimates of the sediment volume in Nurek reservoir were made, but no bathymetric study has ever been implemented to define the actual figure.

- **Downstream Nurek HPP**

The water of the Vakhsh River, downstream of the Nurek HPP, is influenced by the reservoir water quality.

Large and deep reservoirs in temperate climates, like Nurek HPP reservoir, usually show a thermal stratification during summer when water temperature at the surface is significantly higher than water below the reservoir surface. This thermal stratification and water intake for the turbines in deeper (cooler) layers can lead to the input of very cold water into the river downstream of the power plant. Moreover, in the deeper layers of the reservoir the small amount of biomass and the reduced oxygen circulation lead to anoxic conditions that can influence the quality of the water released downstream.

The water quality downstream of the Nurek dam could have a negative impact on the local aquatic ecosystem. Poor water quality would affect the quality of fish habitats, including resources, and reproduction: the modification of the physico-chemical parameters of the environment will disrupt habitat and its resources (nutrients and plants) that would cause disruption of reproduction. However, in the project framework, the species have acclimatized to such environmental conditions. The dam construction, several years ago, has certainly modified the original fish populations. Today the present species are regularly subjected to variations in water quality (temperature, oxygen, ammonia ...) and are adapted to these conditions. Besides, the water reoxygenates as it flows downstream and the water quality improves in this respect.

The rehabilitation of Nurek HPP would not alter these conditions that the local aquatic ecosystem (immediately downstream of the dam) knows for several years.

4.3. Biological environment

Considering the project characteristics, biological impacts are not expected on the upstream environment of the dam, along the access road, at the dam site and its power plant. Thus, the analysis of the biological environment is limited to the study area located downstream of Nurek HPP, and mainly on habitats, fauna and flora species dependent upon the hydrology of the Vakhsh River.

Due to the fact that the project will not cause more impacts than those already observed due to the Nurek HPP, the analysis of the baseline data of the terrestrial flora and fauna is not justified.

4.3.1. Protected areas

a. General

In this section, protected areas downstream of Nurek HPP are identified and characterized carefully because they have a legal protection status. Any interference with them, in any way not in compliance with this legal protection, would be considered to be an illegal activity. Furthermore, such protected areas potentially contain some species of exceptional value or habitats, which must be protected.

In the present project, this is especially true for protected areas which depend on river characteristics (Vakhsh or Amu Darya Rivers).

b. Protected area in Tajikistan: the Tigrovaya Balka National Reserve

Downstream of Nurek HPP, only one protected area has been identified. This area is the **Tigrovaya Balka National Reserve** located downstream of Sangtuda 2 dam.

- **General description**

The Tigrovaya Balka State National Reserve is located in the lowermost part of the Vakhsh river basin, down to its confluence with Pyanj River, close to the border with Afghanistan. It was created by decree n°1163 of the Tajik SSR on November 4, 1938. Its main objective is the conservation of the unique Tugai complex and of the animals living in it. Tugai designates a specific type of floodplain habitat in desert areas of Central Asia. It is characterized by a groundwater level close to the surface, which conditions a specific vegetation type composed of a number of tree species, reeds etc. It is also a habitat for many fauna species. Tugai systems have come under increased pressure through intensified human use of these floodplains.

The reserve, with an area of 49,786 ha, is located about 200 km south of Dushanbe. It is of great importance for the conservation of the Tugai ecosystem and its unique fauna and flora. It was the last habitat of the Caspian Tiger, which became extinct around 1950. Human pressure on this area reached its maximum after the collapse of the Soviet Union and the ensuing civil war. Illegal and uncontrolled logging, hunting and fishing led to a sharp decline of many species - the Bukhara deer, black and golden pheasant, gazelles, the striped hyena etc.

The area has a continental and arid climate. The average annual temperature is +14 to +17°C, the temperature of the coldest month (January) is + 2°C. Temperatures in the hottest month (July) range from 32 to 38°C sometimes reaching 48°C. The length of the frost-free period is 250-310 days. Winters are short and mild, which is typical for dry subtropical zones.

Precipitation is distributed unevenly throughout the year, with up to 70% falling in winter and spring months, usually in the form of rain.

The reserve contains about 20 lakes of different sizes. Their water is poorly mineralized, with about 1.92 to 4.67 mg/l of carbonates. In addition to 438 species of vascular plants, there are about 30 reptile species, 34 mammal species, 2 amphibian species and 150 bird species within the reserve. It is one of the few remaining habitats of the Bukhara subspecies of the red deer or Hangul (*Cervus elaphus bactrianus*).

The main threats to the reserve are the massive development of land adjacent to its borders, the lack of buffer zones, poaching, regular forest fires, reduced water levels in the Vakhsh and illegal logging.

Like every floodplain habitat, it depends directly on the dynamics of the river forming this plain, in this case Vakhsh River. The river dynamics are driven by the amount of water flowing, but to a very great extent also by the seasonal distribution, and especially by seasonal floods.

- **Hydrology**

The ecosystems of the Tigrovaya Balka floodplain depend on a meandering river and its dynamics. These dynamics are conditioned by the variation in river flow, by regular seasonal variations (low flows in winter, high flows in summer) as well as by rare and extraordinary flood events (extreme floods).

The hydrographical network of the reserve is formed by the Pyanj and Vakhsh Rivers. The territory of the reserve is connected to the Vakhsh River which has a temperature dependent regime influenced by glacial and snow melts. Currently, the Vakhsh River is regulated by Nurek, Sangtuda 1 and Sangtuda 2 dams. The floodplain is a highly dynamic system sustained by the ever changing river conditions: seasonal flow variations, successions of dry and wet years, and extreme flood events (Pöyry Energy GA, 2014).

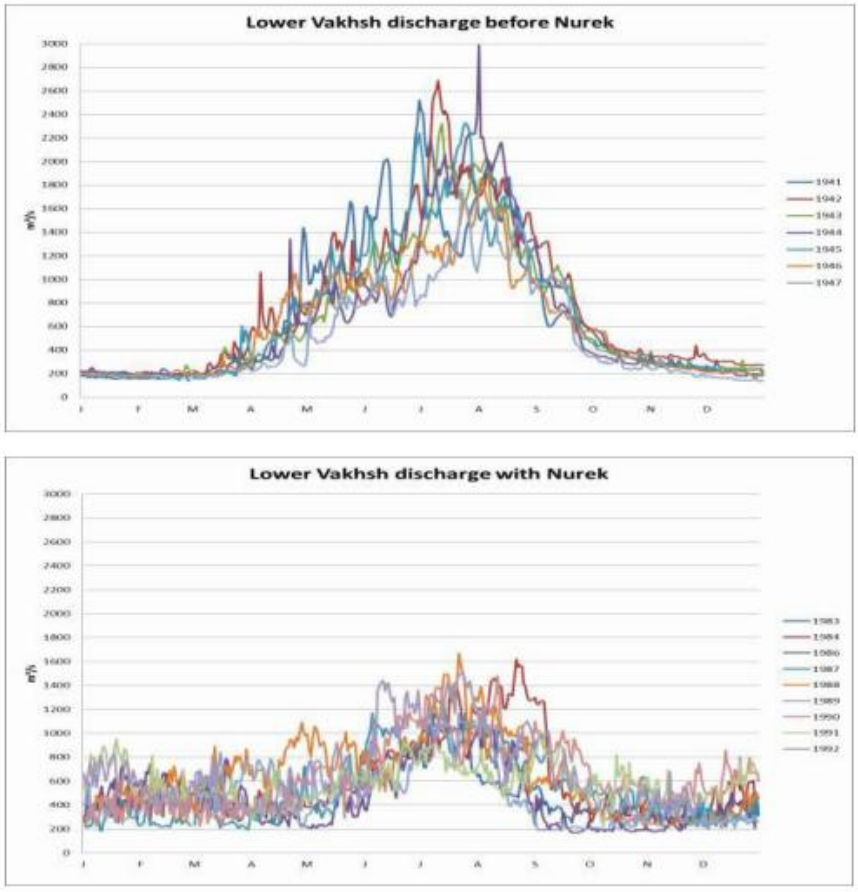
Figure 26 - Satellite image of the Tigrovaya Balka floodplain

- **Effects of river regulation on floodplain ecosystems**

River regulation caused by the large storage reservoir of Nurek HPP has already generated the following main direct effects on floodplain dynamics:

- Shift of water from the wet season (summer) to the dry season (winter). This means that normal summer flooding will on average reach lower levels than it did before, and higher winter flows mean less land will be dry in winter.
- Reduction in frequency and severity of high floods: a large reservoir such as Nurek also has an effect of reducing flood peaks, thereby providing flood protection to downstream areas. This means that the effects of such flood events as described above will be less marked.

Figure 27 - Daily flows in lower Vakhsh without and with Nurek



As the previous figure shows, the discharge pattern of the cascade has modified the natural discharge regime of the Vakhsh River as shown in the figures above. Furthermore, river regulation has modified downstream sediment transport due to sediment trapping in reservoirs (again mainly in Nurek), and this can typically cause a number of adverse effects in the downstream area such as bed and river bank erosion, morphological changes within the river bed, and lowering of ground water tables.

These direct impacts on the floodplain dynamics influence the vegetation in the following ways:

- Areas no longer flooded regularly in summer become gradually colonized by dryland species It is also possible that people start cultivating areas which are flooded only very exceptionally.
- Erosion as well as sediment accumulation processes are slower, while flood events where the river destroys vegetation occur more rarely or not at all.

The entire process can lead to a more uniform habitat becoming inhospitable to many of the plant and animal species that require specific conditions. In addition, the inflow of drainage water from irrigation schemes in the surroundings leads to the input of salts, fertilizers and agrochemicals, which all contribute to changing the situation in the ecosystem (Pöyry Energy GA, 2014).

Tigrovaya Balka is a critical habitat in the sense of OP 4.04: area legally protected on the national level, type of rare habitat with high importance for biodiversity conservation). Unlike the other floodplains affected by the project, Tigrovaya Balka is also an Important Bird Area (IBA) according to Birdlife International (www.birdlife.org/datazone/country/tajikistan/ibas).

c. Protected areas outside Tajikistan

Downstream of the Nurek HPP, outside Tajikistan, along the Amu Darya River, several protected areas associated with the river have been identified.

Three Tugai sites are protected outside of Tajikistan, namely **Amu Darya Reserve** in Turkmenistan, **Kysylkum Protected Area** and **Badai Tugai** in Uzbekistan. They are conditioned by the same dynamic processes as were described above for Tigrovaya Balka, and therefore they suffer from the same impacts: reduction in water flow, change in seasonal flow patterns, invasion of plants not adapted to Tugai conditions and encroachment by human use.

All along the Amu Darya, small patches of this ecosystem remain outside protected areas; not being protected however does not mean that they have no ecological value; they are basically a habitat for the same set of plant and animal species as the protected parts.

Effects could arise due to changes in water regime of the river. However the water coming from Nurek HPP, unlike in the case of Tigrovaya Balka, constitutes only a small part of the total amount of water (naturally) flowing here, and flow conditions are not mainly controlled by Nurek HPP, but by the other numerous hydraulic structures along the course of the Amu Darya.

The influence of Nurek HPP on Amu Darya, Kysylkum Protected Area and Badai Tugai is therefore marginal.

4.3.2. Terrestrial flora

a. General

This chapter focuses on habitats dependent on the Vakhsh River and/or the Amu Darya River that can be influenced by the modification of the water flows during and after the rehabilitation of Nurek HPP: floodplains.

The vegetation of the downstream floodplains has been influenced and changed since a long time by human activities, mainly HPP cascade but also agriculture.

The description of vegetation and flora of the area to be affected by the Project will focus on vegetation on the land that might be affected by changes in river discharge pattern by the Project (mainly Tigrovaya Balka National Park).

b. Baseline

Floodplains along large river systems like the Amu Darya usually have a high biodiversity and provide a wide range of ecosystem services for the human population.

In the floodplains in this zone *Juglans regia* (walnut), *Platanus orientalis* (sycamore), *Populus spp*. (poplars) and a number of *Salix spp.* (willows) can be found.

Tugai complexes are widespread in the floodplains of rivers dominated by *Populus euphratica* (Niels Thevs and al., 2011)[8], *Populus pruinosa* and *Elaeagnus angustifolia.* Tugai, alternated with bushes of giant reeds (*Phragmites communis*), *Erianthus ravennae*, sugar-cane (*Saccharum spontaneum*) are also widespread in low-lying areas.

Water reservoirs and wetlands of the reserves are widespread along the Vakhsh and Pyanj. Ox-bow lakes are densely overgrown by water vegetation: *Myriophyllum L. sp.*, different species of pondweed, hornwort, and buckwheat and somewhere by naiad.

4.3.3. Terrestrial fauna

a. General

Regarding the potential impact of the project, fauna occupying or using floodplain habitats are the only fauna that can be indirectly impacted by the project (through the modification of these habitats linked to the river flow).

As explained in the previous chapter on vegetation, all habitats in the project area are strongly influenced by human use, and therefore have been changed and degraded. Downstream of Nurek HPP, habitats and thus fauna, which depend on water flow, have already been impacted by the construction and operation of Nurek HPP. This situation is considered in the present study as the baseline.

b. Baseline

In an article dated 1980 regarding the Nurek reservoir environment, Beilinson et al (Beilinson *et al.*; 1990)[9] established the ecological situation in the region of the reservoir. Before the construction of the dam, practically no zoological investigations were carried out. A census of wild animals was taken only in 1978 and 1989.The main observations were the wild boar (*Sus scrofa*), Siberian ibex (*Capra sibirica*) and urial (*Ovis orientalis*). The urial has been entered into the red list of the IUCN as "vulnerable". We suppose that these species can also be found downstream of the dam.

The floodplain of the Vakhsh River and riparian vegetation are particularly important. Both amphibian species and 5 reptile species can be found in the floodplain area. The *Vipera lebetina* (Blunt-nosed viper) is categorized as an endangered species by IUCN. Just 9 species of mammals have been identified for the floodplain. *Lutra lutra seistanica* (Eurasian otter) is one of the key species in the floodplain habitat and is categorized by IUCN as near threatened. However, its presence in the floodplains downstream of Nurek HPP has not been confirmed. 44 bird species are found in the floodplain, 26 of them nest in the floodplain. Eighteen species mainly water birds (ducks, goose, little egret, grey heron etc.) can be considered as migratory species for spring or autumn (Pöyry Energy GA, 2014).

[8] Niels Thevs, Allan Buras, Stefan Zerbe, Elfi Kühnel, Nurbay Abdusalih, and Amangul Ovezberdiyeva "Structure and wood biomass of near-natural floodplain forests along the Central Asian rivers Tarim and Amu Darya", Forestry 2011: cpr056v1-cpr056

[9] Nurek reservoir and the environment, M. E. Beilinson, A. V. Kolichko, S. M. Sherman, 1990

4.3.4. Aquatic fauna

a. General

The chapter focuses mainly on fish. The baseline of the aquatic fauna, upstream (reservoir) and downstream of the dam is the already modified condition with the presence and operation of Nurek HPP. Thus, the obstacle to up/down migration ("dam" effect) for migratory species , the change from river to lake upstream of the dam, and the change of the downstream flow impacting such areas as spawning areas, and the possible introduction of exotic species in the reservoir (as compensation for the development of a fishery) are already existing impacts.

b. Baseline

According to the Rogun HPP ESIA, no long range fish migration presently takes place in the Vakhsh River. If such migrations existed earlier, they were definitely interrupted by the construction of Nurek dam. Given this fact, Vakhsh River is not considered as a natural habitat. In any case, Vakhsh River with its exceptionally high sediment load (up to 4,000 g /m^3) does not favor fish migrations.

- **Upstream Nurek HPP (reservoir)**

In the upper part of Vakhsh (Surkhob) River, in the region of Jirgital and further upstream, there are a number of small lakes which are connected to the river, and in this area there are populations of Amu Darya trout (*Salmo trutta oxianus*), brown trout (*Salmo trutta fario*) and common marinka (*Schizothorax intermedius*). Fish species present in the river system upstream of Nurek dam still carry out short range migrations, e.g. between Vakhsh River and its tributaries.

During the first 10 years of the Nurek HPP reservoir, the fish population consisted mainly of common Marinka (*Schizothorax intermedius)*, Samarkand khramulya (*Varicorhinus keratensis stendachneri*), Turkestan catfish (*Glyptosternon reticulatum*), Amu Darya trout (*Salmo trutta oxianus*), etc. However, once the reservoir reached its full supply level, the input of organic material stopped, and nutrients were washed out of the reservoir. Productivity went down again. For this reason, over the last 20 to 25 years the fish species mentioned above have disappeared almost completely from Nurek reservoir. One species, the peled or Northern Whitefish (*Coregonus peled*), a pelagic plankton feeder, had been introduced to in the reservoir at the beginning of the filling phase. The population grew over the first few years dying out at the end of the filling phase due to the development of more oligotrophic conditions (lack of nutrients). A number of exotic fish species were introduced into Nurek reservoir with limited success. The following Table provides a list of fish species from the wider area, with some indications on distribution.

In 2011, specific investigations in the Nurek HPP reservoir for the Rogun HPP project give us several pieces of information. Today, none of the species still present in Nurek reservoir is found in substantial numbers. The conditions in the reservoir are not suitable for the development of fish stocks. The massive reservoir drawdown that occurs is a severe limiting factor.

Table 10 - Fish species in Nurek reservoir

Family	English name	Scientific name	1979-1982	2011
Salmonidae	Amu Darya trout	*Salmo trutta oxianus*	Frequent	Rare
	Brown trout	*Salmo trutta fario*	Frequent	Rare
	Rainbow trout	*Oncorhynchus mykiss (Salmo gairdneri)*	Introduced	Rare
Coregonidae	Peled	*Coregonus peled*	Introduced	Absent
Cyprinidae	Marinka	*Schizothorax intermedius*	Frequent	Absent
	Khramulya of Samarkand	*Capoeta (Varicorhinus) capoeta*	Frequent	Absent
	Carp (sazan)	*Cyprinus carpio*	Introduced	Present
	Silver carp	*Hypophthalmichthys molitrix*	Introduced	Present
	Spotted silver carp	*Hypophthalmichthys (Aristichthys) nobilis*	Introduced	Present
	Chebachok of Amur	*Pseudorasbora parva*	Introduced	Present
	Striped bystranka	*Alburnoides taeniatus*	Introduced	Present
Cobitidae	Tibetan loach	*Triplohysa (Nemacheilus) stoliczkai*	Frequent	Present
	Crested loach	*Paracobitis (N.) malapterura*	Frequent	Present
	Tajik loach	*Iskandaria kuschakewitschi (N. pardalis)*	Frequent	Absent
Sisoridae	Turkestan catfish	*Glyptosternon reticulatum*	Frequent	Absent
Gobiidae	Amur goby	*Rhinogobius similis*	Introduced	Absent

(Source: Rogun HPP EIA, Pöyry Energy AG, 2014)

- **Downstream of Nurek HPP**

Investigations have been done for Rogun HPP EIA. Due to the location of this project located 70 km upstream of Nurek site, we can suppose that the same species can be found downstream of Nurek HPP.

The fish fauna in the Vakhsh, downstream of Nurek HPP include the common Marinka, Turkestan catfish, Amudarya trout, rainbow trout, brown trout, Tibetan stone loach, crested loach and Carps.

4.4. Human environment

4.4.1. Administrative context

The Nurek HPP is located 80 km (by road) from Dushanbe, the capital of Tajikistan, in the Danghara and Nurek districts of Southern Tajikistan, in the Khatlon Province.

Its reservoir is located both in the regions of Khatlon and Region of Republican Subordination. Khatlon has an area of 24,800 km^2 (around 17% of the country's area) and consists of 24 administrative districts, four towns and 133 rural jamoats[10]. The region is informally split into Western Khatlon (comprising Kurgan-Tube and the Kofarnihon and Vakhsh river valleys) and Eastern Khatlon (Kulyob and the Kyzylsu and Yakhsu river valleys). Kurgan-Tube is located only 100 km from Dushanbe.

Figure 28 – Administrative map of Tajikistan

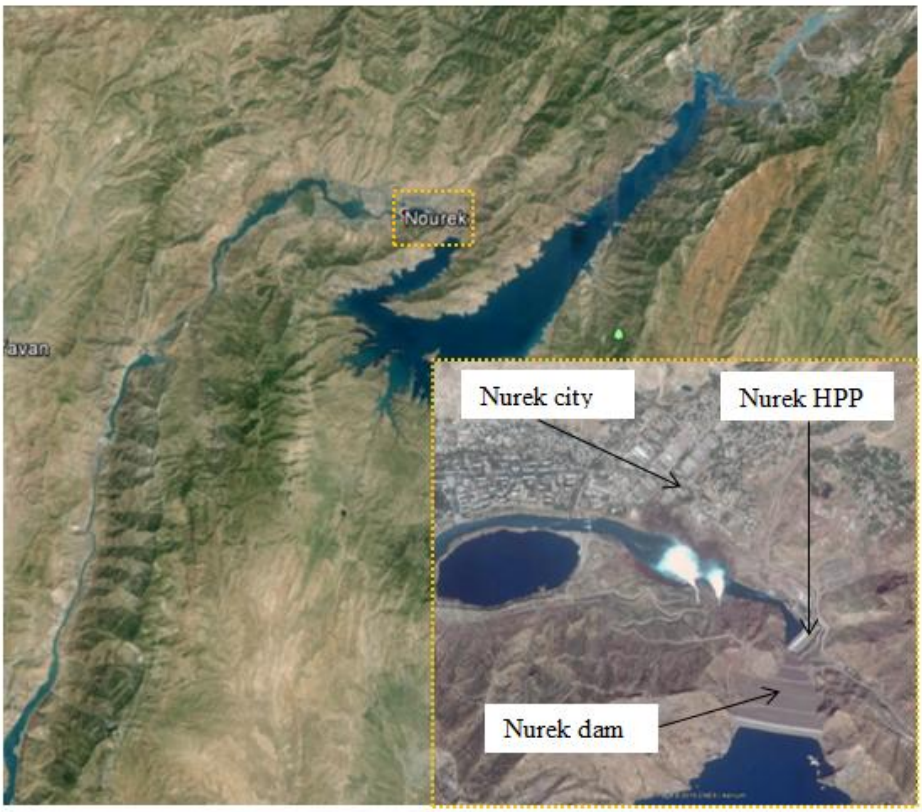
Nurek HPP is located in the vicinity of Nurek City. The city is situated on the Vakhsh River, 885 m above sea level, and is 70 km southeast of Dushanbe, the capital. It has a population of 18,950 (2008 estimate)[11].

10 Third-level administrative divisions, similar to communes or municipalities

11 "Tajikistan". World Gazetteer. Retrieved 9 February 2008

Figure 29 - Khatlon Region districts[12]

Figure 30 - Nurek city location



4.4.2. Socio-economic context

4.4.2.1. GENERAL SOCIO-ECONOMIC CONTEXT

a. City of Nurek

As previously mentioned, Nurek HPP is located close to the city of Nurek. The city was founded in 1960 alongside the construction of Nurek Dam. Available data on the city are as follows:

[12] Khatlon – mapping of donor supported projects in agriculture (World Bank, 2012)

- **Administrative authorities and services**: Mayor, Department of Social Development and Communication with the Public, Department of Organization and Labor, General Department of Citizen Monitoring and Treatment. Two fire stations, one for the city and the other dedicated to the HPP, are present in Nurek. There is also a Russian military base and a Tajik military base.

- **Educational institutions** (http://norak.tj/?show=maorif-ru&lang=ru&mId=44):

Table 11 – Educational institutions in Nurek

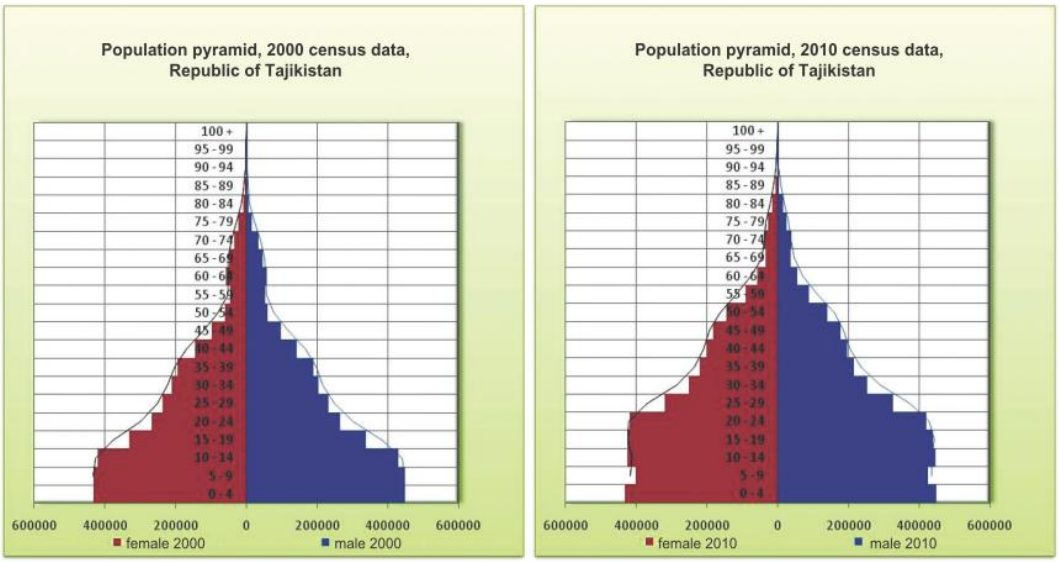
Type	Kindergarten, nursery school (< 7 y.o.)	Primary School (8-10 y.o.)	Secondary School (11-17 y.o.)	Gymnasium	High School	MTI	Total
Number	11	4	17	1	1	1	35

Officially, the country has a literacy rate of 100%.

- **Health facilities** (http://norak.tj/?show=tandurusti-ru&lang=ru&mId=32): 1 city hospital, 1 health center, 3 rural health centers, 13 isolated health centers, the Sanitary and Epidemiological Station, 1 Center for Childhood Illnesses, 1 Center for the Development of Good Hygiene, a vaccination center and the center for the fight against tuberculosis.

- **Population**: The Nurek population was estimated to be 28,100 inhabitants in 2015(http://www.undp.org/content/dam/tajikistan/docs/projects/democratic_governance/UNDP_TJK_MHDT_2014_Eng.pdf). The structure of the population corresponds roughly to that of the country, i.e.:

Figure 31 – Population of Tajikistan by age and gender according to the 2000 – 2010 census data



- **Religion**: The city of Nurek is Muslim in its vast majority, with a "moderate" Islam practice in accordance with the secular governance of the country. Some practice of a fundamental Islam is reported, but it's the fact of a minority. The rest of the population, around 10%, is orthodox. Places of worship reflect this distribution, with only one Orthodox church and mosques for the rest.

- **Economy**: Apart from Nurek HPP, industry is represented by a reinforced concrete structure factory and a textile factory. There are also local markets, a central market, several commercial streets (agricultural products, textiles, computers...), crafts (garages, woodworking ...) and mainly subsistence farming in the vicinity. Construction activities constitute the heart of economic activity.

  At national level, unemployment is 2.5%, but locally it is probably higher (no local data available nevertheless); many young people leave the region, often to go to Russia, for lack of prospects.

  A summer tourism development can be reported linked to the exploitation of reservoir potential and other ancillary activities still linked to the Vakhsh (nautical, fishing, restaurants...) (https://tajikistantourism.org/destinations/norak-nurek/), and there is an active socio-cultural center in the city. But one can only find three or four hotels inside the city (one relatively big), and a movie theater that no longer works.

- **Infrastructure**: Main road is in good condition, secondary roads are in average or bad condition as one moves away from the center of the city. Drinking water system exists, but sometimes fails. Electrical network is in good condition, better than in the rest of the country. Telecommunications (telephone and Internet) are also present.

- **Cultural heritage**: Since the city was founded in 1960, there is no ancient historical heritage in the city, but some small physical cultural resource were found over time. There is also a museum in Nurek City.

b. Khatlon Region

Downstream of Nurek HPP, the Vakhsh River is located in the Khatlon Region. Several localities are located close to the river: Sangtuda, Gulistan, Kazanguzar, Sarband, Qurgonteppa, Kolkhozabad, Jilikul, etc. Along the access road (A385 and M41), localities are mainly located in the vicinity of Dushanbe: Tezgar, Neftyanik, Vahdat, Rohati, etc.

The project area and the region are largely rural (83% in the Khatlon Region) and remain predominantly dependent upon primary agriculture. Less than 3% of the population is employed in the industrial sector. The project area, as is the Khatlon Region, is a major agricultural region with the highest rates of undernutrition and the largest number of people living below the poverty line[13]. The region accounts for half of the agricultural output of the country, including 65% of total cotton production. Khatlon's irrigated watersheds and cotton-dominated agricultural production is a promising sector to demonstrate the effect of water and land reforms.

[13] Feed the Future, Tajikistan fact sheet.

According to the 2009 Living Standards Measurement Survey (LSMS), Khatlon has become the poorest region in the country with a 54% poverty rate. Being the largest region in the country (36% of the total population), Khatlon has a higher rate of population growth than the national average. The average size of households is a staggering 8.5 people. Given the high percentage of the youth in the total population (almost 40% below 14 years old), Khatlon accounts for only approximately 14% of the labor force and at the same time is characterized by a very high unofficial unemployment rate (35%) (World Bank, 2013)[14]. The official unemployment rate is 7%.

4.4.2.2. AMU DARYA BASIN WATER USES

a. Introduction: water allocation in the Amu Darya Basin

Water allocation is calculated annually by BVO Amu Darya based on estimations of:

- Snow in the mountains;
- Water stored in reservoirs;
- Water needs given by each representative of BVO Amu Darya.

The following table shows that on average between 1992 and 2010, water allocation by country is below the water volume allocation estimated in 1987 (Protocol 566). All countries have systematically used less than their water share during years when water availability largely exceeded the forecasts (see after).

Table 12 - Average water allocation by country compared to Protocol 566

Allocation by BVO Amu Darya	Tajikistan	Kirgizstan	Uzbekistan	Turkmenistan	Total
Protocol 566	9,500	400	29,600	22,000	**61,500**
Average allocated (1992-2010)	8,845	216	21,378	20,960	**51,400**

(Source: Rogun HPP EIA, Pöyry Energy AG, ICWC website)

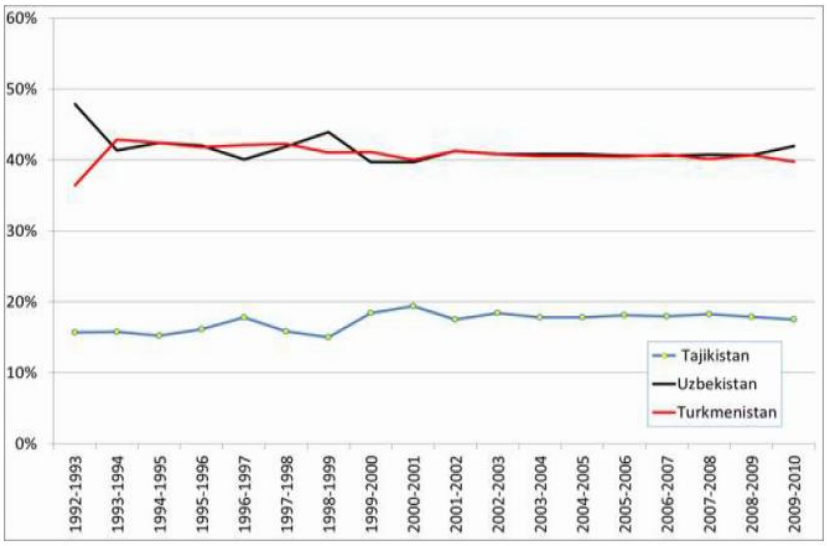
The volume allocated to each member country is calculated as a share of the total allocation. This share has appeared to be rather steady in recent years (see Figure 32).

Nevertheless, as shown in the

Figure **33**, the actual water flow in Amu Darya does not match with the estimations used to calculate the allocation by country. Sometimes, the actual flow in the Amu Darya exceeds the water flow estimation and thus exceeds the total volume of water allocated. However, more often, the actual flow in the Amu Darya is less than the forecasts and less than the total volume of water allocated. Over the period 2000-2010, ICWC forecasts have more often overestimated rather than underestimated water availability (Rogun HPP EIA, Pöyry Energy AG).

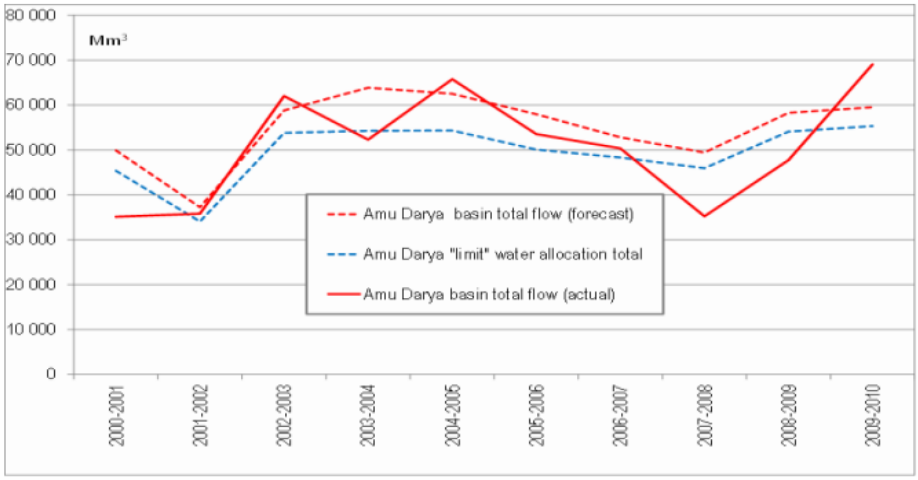
[14] Tajikistan, Reinvigorating Growth in the Khatlon Oblast; World Bank 2013.

Figure 32 - Relative water allocation to Tajikistan, Uzbekistan and Turkmenistan from 1992 to 2010



(Source: Rogun HPP EIA, Pöyry Energy AG, ICWC website)

Figure 33 - Amu Darya forecasted, allocated and actual flows (1992 to 2010)



b. Agriculture/Irrigation

- **Irrigation and drainage**

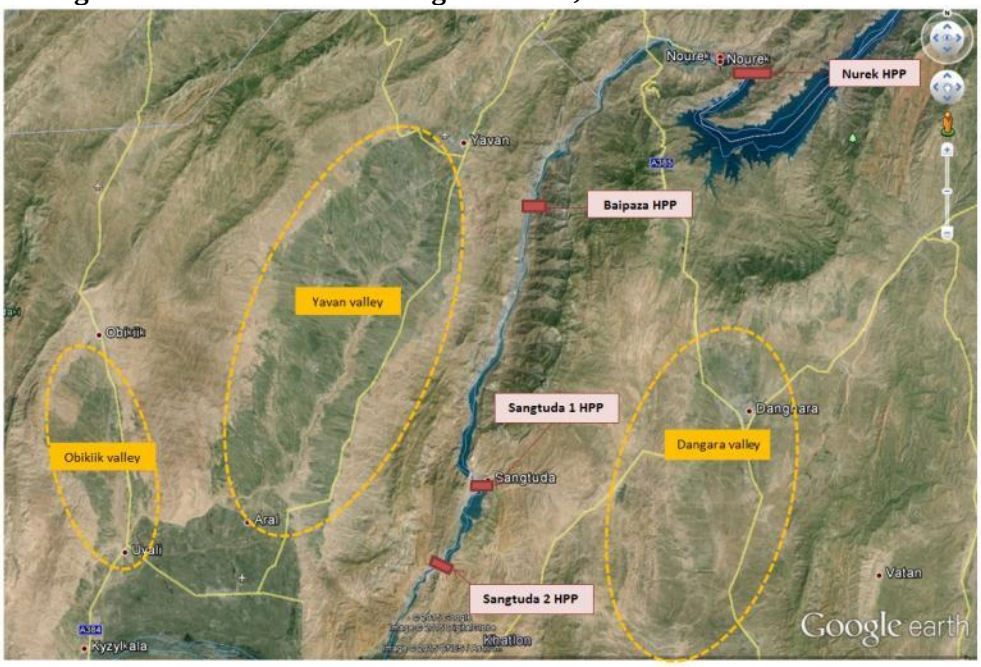
Under the Soviet economic system, Central Asia was a source of agricultural products, energy and minerals. The Soviet Union invested massively in developing an immense system of dams, canals and water pumping stations. The period between 1950 and 1990 saw huge investments in the water infrastructure of the region with the construction of reservoirs, irrigation canals, pumping stations and drainage networks for irrigation to support the cultivation of cotton, wheat, fodder, fruit, vegetables and rice in the arid steppe and desert areas. Between 2005 and 2010, the average area under irrigation in the Amu Darya basin exceeded 5 million hectares.

Uzbekistan has the largest area under (large-scale) irrigation followed by Turkmenistan, Tajikistan and Afghanistan[15] (ENVSEC, 2011).

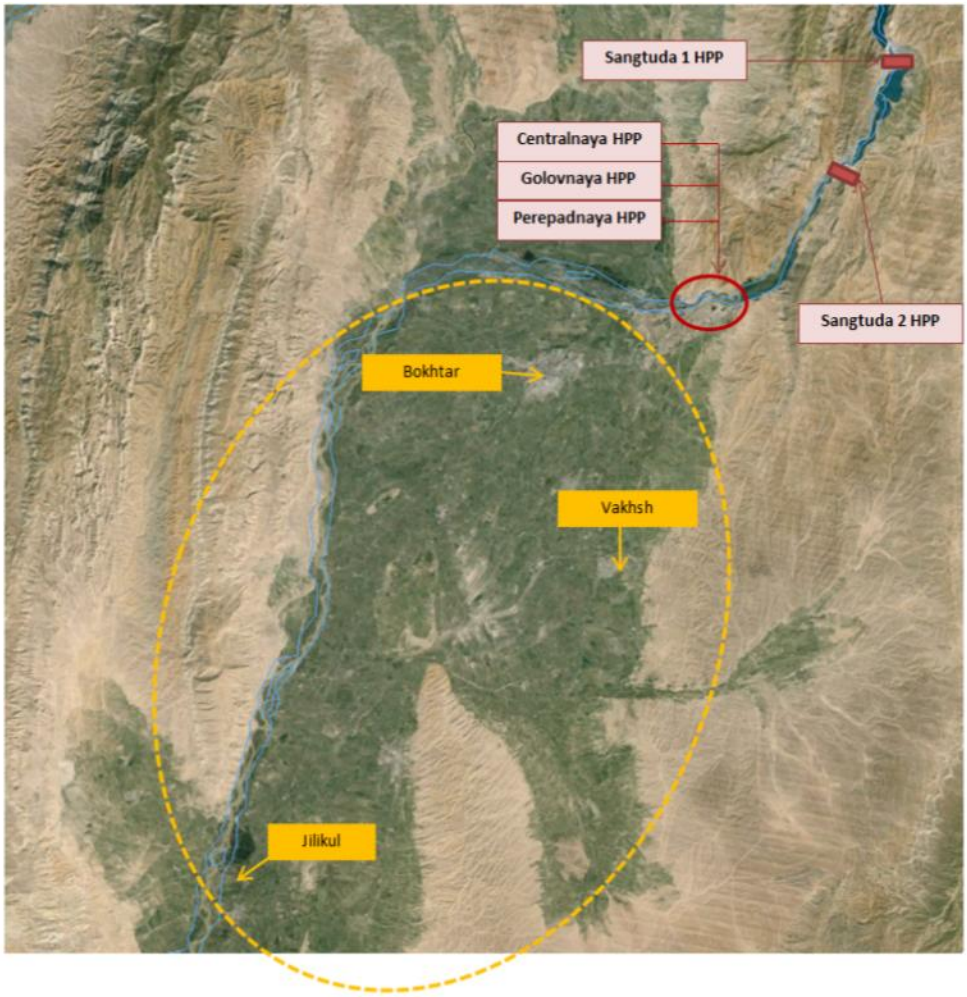
Along Vakhsh River, there are several irrigation schemes. All irrigated lands are located downstream of Nurek HPP:

- The Dangara tunnel with a capacity of 100 m³/s was built to irrigate the land in the Dangara area (70,000 ha) 14 km far from Nurek HPP through a tunnel linked to the Nurek reservoir;
- The Yavan tunnel with a capacity of 75 m³/s supplies water to the Yavan and Obikiik valley irrigation scheme (40,000 ha) The Yavan tunnel is 7.3 km long and supplies water from the Baipaza reservoir.
- The Vakhsh main canal with a capacity of 210 m³/s is used to supply irrigation water in the regions of Vakhsh, Bokhtar, Jilikul, Kumasangir and Rumi.

Figure 34 - Location of the irrigated areas, downstream of Nurek HPP



[15] Uzbekistan 2.3 million ha; Turkmenistan 1.7 million ha; Afghanistan 0.4 million ha; Tajikistan 0.5 million ha (Horsman, 2008; FAO, 2007, BVO, 2008).



In addition to these major systems there are also several small size irrigation systems that provide public and private farms with irrigated water.

Finally, a significant part of agricultural land in southern Tajikistan is currently not irrigated because of the poor conditions of the irrigation infrastructure.

Figure 35 – Water resources in the Aral Sea basin

- **Agriculture and economy**

Today, the economies of the region are still essentially agricultural, especially with regards to the predominant occupation of the labor force. In 2007-2008, agriculture constituted about 20% of national GDP in Tajikistan, 25% in Turkmenistan and more than 28% in Uzbekistan. Agriculture employs 67% of the labor force in Tajikistan, 45% in Uzbekistan and 48% in Turkmenistan. In the case of Afghanistan some 80% of the population depends on farming and herding (UNEP, 2003). Besides, 68% of women are employed in agriculture.

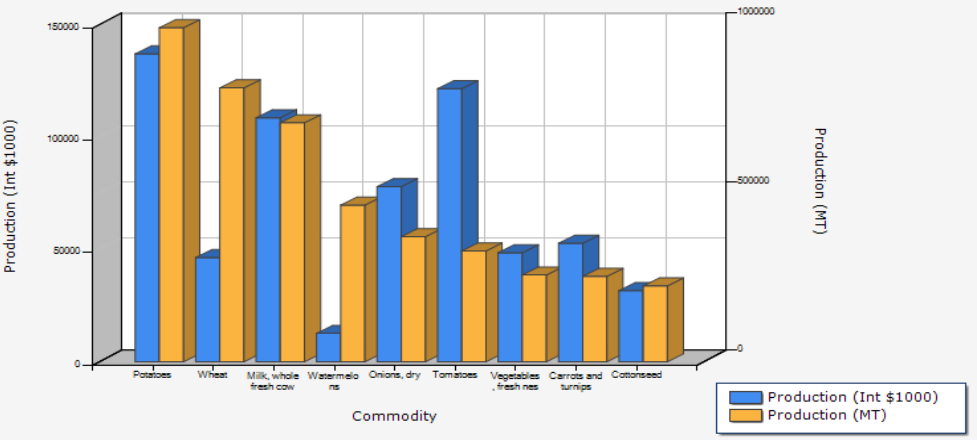
- **Production**

Wheat is the main crop cultivated on both irrigated and rain-fed land. All the countries in the region except for Afghanistan rely on primary exports (cotton, oil and gas, gold, aluminum) to earn foreign exchange (ENVSEC, 2011).

Under the Soviet Union wheat was imported to the Amu Darya basin mostly from other Soviet republics in exchange for cotton. At independence wheat imports had to be paid for in foreign currency and this quickly became a major burden for states and also turned into a food security issue. To decrease dependence on outside food sources, governments opted to shift production away from cotton to wheat. Since independence in 1991, agriculture has been diversified. Nevertheless, as shown here after, although wheat is becoming the first production in terms of quantity, cotton lint remains the most important production in terms of value.

- **Tajikistan**. With nearly 991,044 MT/year, potatoes are the number one cash crop in Tajikistan followed by wheat and watermelons, whilecottonseed is the eighth (225,000 MT). Cotton lint occupies thirteenth place in terms of quantity produced (121,000 MT), but the first place in terms of earnings, followed by wheat. As can be seen in Figure 37, cotton is grown in the irrigated valleys of the Vakhsh River basin downstream of Nurek HPP.
  With 43% of Tajikistan's irrigated lands growing cotton in 2001, little space is left for grain and vegetable crops, contributing to the country's continuing food deficit (UNDP, 2003)[16].

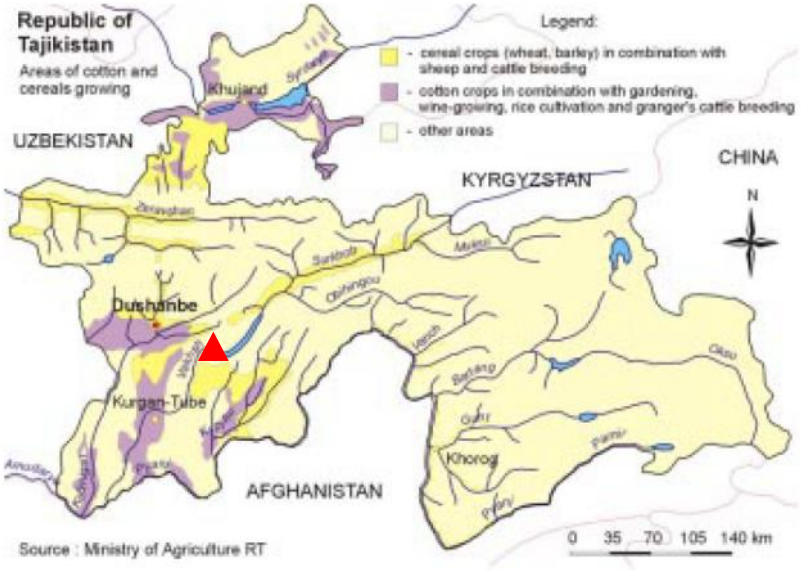
Figure 36- Top production - Tajikistan (2012)



(Source: FAO, 2012)

16 Tapping the potential. Improving water management in Tajikistan. UNDP, 2003.

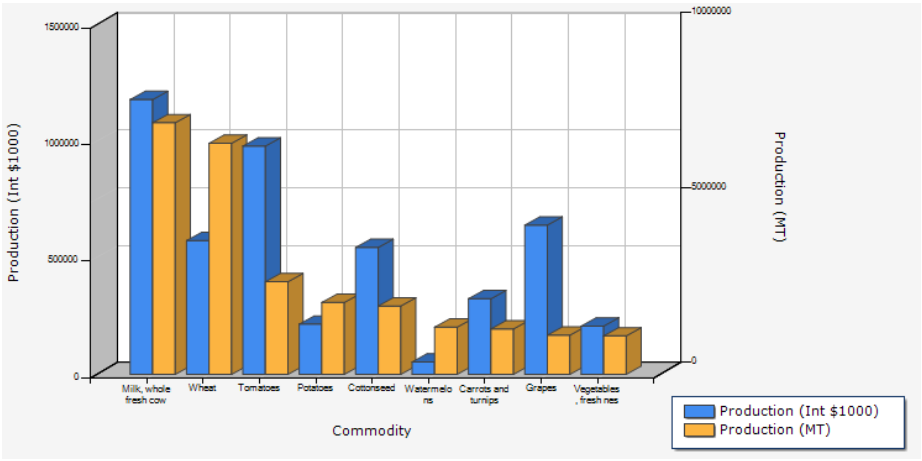
Figure 37 - Areas of cotton and cereal growing in Tajikistan



Nurek HPP (Source: UNDP, 2003)

- **Uzbekistan**. In the early 1990s about half of irrigated lands in Uzbekistan were used to grow cotton, the rest being used for food. At present, irrigated cotton only accounts for 30% of the whole, the rest is used for food crops. From a production point of view, wheat is the number one crop (6,609,000 MT), followed by tomatoes, potatoes and cottonseed (FAO, 2012). In terms of production, cotton lint is ranked tenth (1,052,000 MT) and second in terms of value. Uzbekistan is the sixth highest producer of cotton lint in the world (FAO, 2012)[17].

Figure 38 - Top production - Uzbekistan (2012)



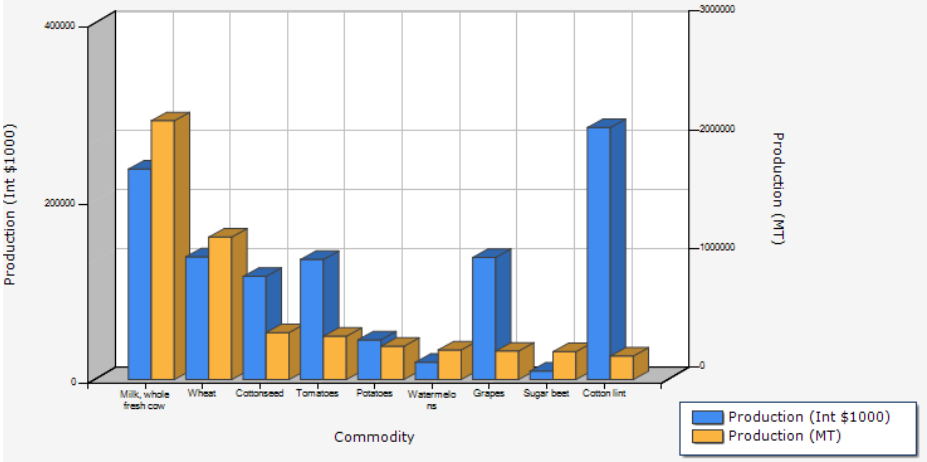
(Source: FAO, 2012)

- **Turkmenistan**. The country has substantially increased grain production recently. With 1,200,000 MT wheat is the number one crop, followed by

[17] http://faostat.fao.org/DesktopDefault.aspx?PageID=339&lang=en&country=235

cottonseed, tomatoes and potatoes. Cotton lint is ninth in terms of production but first in terms of value.

Figure 39 - Top production - Turkmenistan (2012)

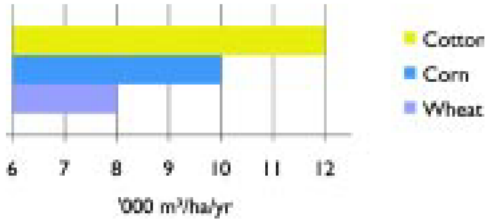


(Source: FAO, 2012)

In summary, for the Vakhsh and Amu Darya riparian countries, cotton production is very important because it is one of the most valuable export commodities.

Cotton production is highly water intensive.

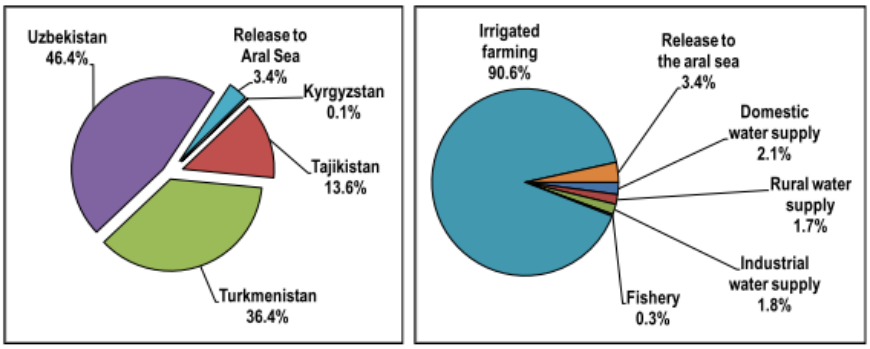
Figure 40 - Crop's water demand



- **Water demand and seasonality**

Currently, approximately 90% of the water demand in the Amu Darya Basin is for irrigation.

Figure 41 - Country and sector distribution of Amu Darya water use (1997)



(Source: BVO)

Apart from water use, irrigated agriculture implies the discharge of drainage water back to the Amu Darya from irrigated fields in the mid- and upstream reaches: about 3-4 km^3 are discharged directly into the river every year (ENVSEC, 2011). Drainage water constitutes 30% of the water consumption in the Amu Darya basin. Greater amounts of drainage water are diverted into the deserts and other lands deemed unsuitable for cultivation. Despite its significant volume, drainage waters in general do not count as a resource. A fraction of irrigation runoff is used to supplement irrigation water, especially in dry years. Much of the irrigation runoff is discharged and lost in the desert and a significant amount flows back into the middle and lower Amu Darya, increasing the quantity but substantially decreasing the quality of water and making it unsuitable for drinking (Rogun EIA, Pöyry Energy AG).

Most of the water used for irrigation is taken during the vegetation period ("summer period") which, subject to the altitude and type of crop, extends from April to October. The months between November and March may be considered as the "winter period". A first consumption peak is observed in March which corresponds to the use of water for artificially inundating the fields before the start of cropping.

A significant water deficit frequently occurs in February and March due to the current irrigation practice in the Amu Darya (Froebrich *et al.*, 2005).

In Uzbekistan, additional regulation of the Amu Darya water flow would have a serious negative impact on agricultural production because c of the water intensive nature of cropping and because extra water availability in winter months does not make up for the reduction in growing-season irrigation capacity.

c. Hydropower

- **Nurek HPP**

The largest hydropower schemes of the Amu Darya basin are located in the Vakhsh River basin.

Nurek HPP, commissioned in 1972, is the largest HPP and the second largest regulation reservoir in the Amu Darya River basin (after Tyuyamuyun reservoir in Uzbekistan). Nurek is the second highest dam in the world, and provides around 70% of the electricity produced in Tajikistan and satisfying 98% of the electricity demand. Nurek is the only reservoir in the upper Amu Darya basin (i.e. in Kafirnigan, Vakhsh and Pyanj basins) with an interannual regulation capacity.

Previously the dam accumulated water from November to April and released it from May to August-September to maximize (or guarantee) water for agriculture. The current Nurek operating regime provides for increased water discharge in late winter to generate energy. Downstream of the HPP, this water seems to be used mainly for end-of-season irrigation and off-season leaching. The dam's current operating mode should not significantly affect downstream agriculture since outflow does not contribute a great deal to the total flow in the Amu Darya (Wegerich *et al.*, 2007). However, silting increasingly impedes Nurek's ability to satisfy demand for irrigation and energy, storage capacity having been reduced by almost 20 per cent in the last 30 years.

- **Downstream of Nurek HPP**

There are 6 HPP downstream of Nurek HPP in the Vakhsh River, all run-of-river schemes.

Table 13 - Characteristics of Vakhsh River cascade HPPs

HPP	Regulation capacity	Reservoir			Installed capacity	Head (m)
		Total volume (hm^3)	Active storage (hm^3)	Surface		
Nurek	Annual	10,500	4,536.8	98	3,000	265
Baipaza	Weekly-daily	97	80	8.04	600	60
Sangtuda 1	Daily	258	12	9.75	670	64.4
Sangtuda 2	Daily	66.5	3.53	-	220	22
Golovnaya	Daily	94.5	18	7.5	210	23.3
Perepadnaya	Daily	-	-	-	29,9	-
Centralnaya	Daily	-	-	-	15,1	-

The Tuyamuyun Hydrocomplex (THC) downstream of Nurek is located 300 km south of the Aral Sea. THC was constructed to provide water for irrigation, industry, and drinking water for the lower Amu Darya region. The installed capacity of this complex is 150 MW. The operation of the THC depends largely on the inflow regime, and this is strongly influenced by releases from the Nurek reservoir.

There are some small hydropower schemes in the Pyanj river basin (in particular the Pamir HPP near Khorog), which all work as run-of-river schemes (without regulation capacity) and therefore do not affect the seasonality of the Amu Darya flows. The Kafirnigan river basin also has several small run-of-river hydropower schemes, notably in the Varzob river close to Dushanbe. In Uzbekistan, hydropower schemes exist in the Zeravshan and Kashkadarya basins (notably, Gissar HPP).

Figure 42 – Upper Amu Darya basin hydropower potential

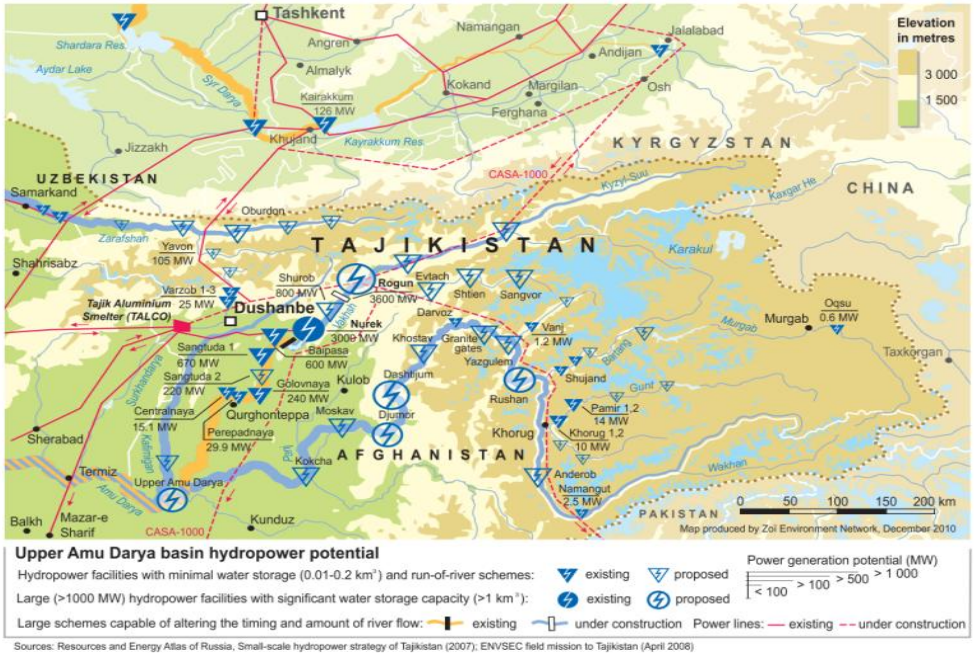
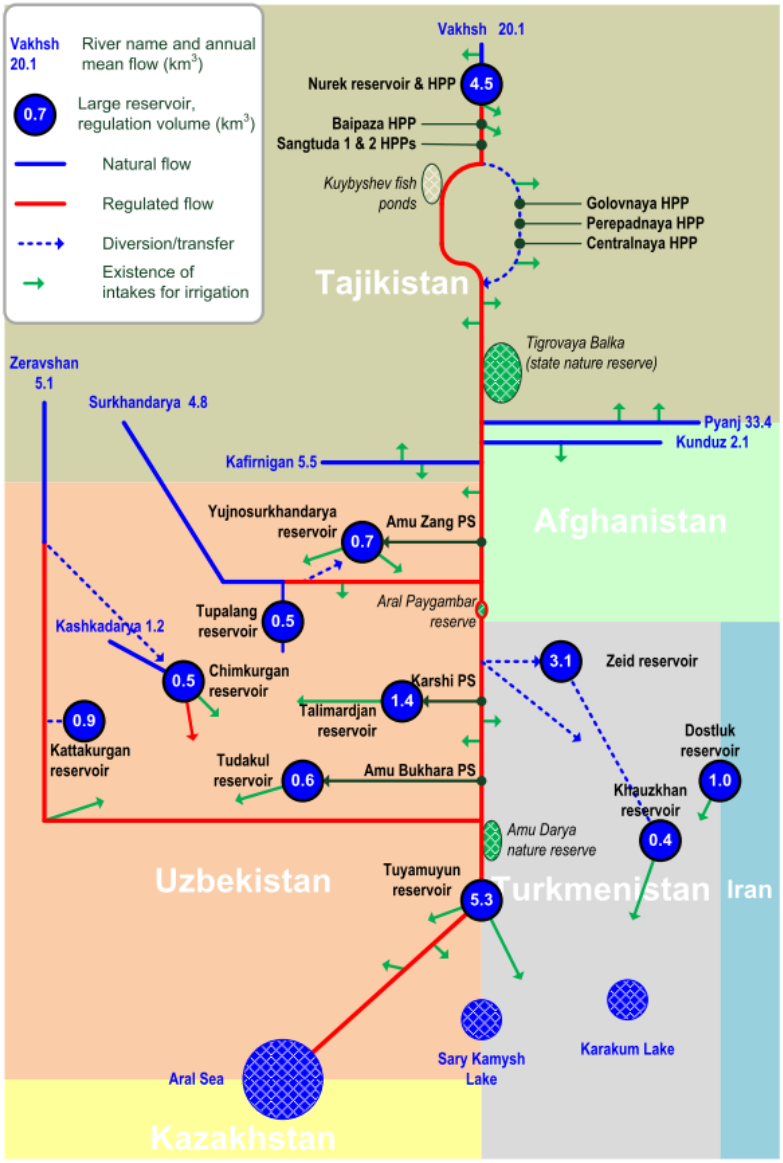


Figure 43 - Amu Darya regulation scheme



(Source: Rogun HPP EIA, Pöyry Energy AG)

The Rogun dam and power plant are being constructed on the Vakhsh River, upstream of the Nurek dam. Tajikistan sees Rogun primarily as a key component in its energy independence.

Industry (mainly aluminum production), agriculture (mainly electrical pumps for irrigation) and the public sector are the main users of energy. The amount of electricity consumed by the population has risen by more than 300% since independence. The growth of industrial power consumption is linked to increasing aluminum output by Tajik Aluminum Company (TALCO). (ENVSEC, 2011).

d. Navigation

In the past the Amu Darya provided a major transport route into and out of the Central Asian region. In 1953, the Amu Darya was navigable over a 2,000 km stretch, from the Aral Sea to the lower reaches of Pyanj River (*Annales de Géographie*, 1953).

Historical data indicates that barges at least up to 500 tons were commonly used on the Amu Darya, which was the only navigable waterway for Afghanistan and Tajikistan.

During the Soviet era, long distance river travel became restricted by the construction of permanent pontoon bridges and in the 1980s by the construction of Tyuyamuyun dam.

In addition, water use for irrigation has resulted in increasing limitations to navigation possibilities, due to the decrease of water levels in the Amu Darya lower reach. Navigation on the Amu Darya downstream of the Tyuyamuyun dam is almost impossible today.

Navigation on the Amu Darya and on the Vakhsh and Pyanj rivers is nowadays limited to local activities using small boats: local transportation, fishing, tourism, riverworks etc. (www.karakalpak.com).

e. Domestic and industrial uses

Over 90% of water abstracted or diverted from the Amu Darya basin is) used for irrigation needs. Other uses are for domestic and industrial needs.

The volumes of water used for industrial, rural and urban needs are in the same order of magnitude: and make up a total of about 5% of the volume abstracted from the Amu Darya (see Figure 41).

f. Fisheries and aquaculture

- **Historical evolution**

During the last 30 years, the Amu-Darya waters have been used for large-scale irrigation leading to the construction of numerous irrigation canals (Karakum canal, Karshi and Amu-Bukhara canals, etc.). A number of water storage reservoirs were also constructed. The impact of human measures on the river has been far reaching on fish. The chemical composition of the river water has changed under the impact of the discharges of drainage waters from irrigated fields and from industries. Regulation of the Amu Darya, manipulation of the flow for irrigated agriculture, and the introduction of Far Eastern fish (especially Chinese carps) in the 1960s led to radical changes in the river biota. Some fish species, whose life cycle was dependent on the river delta, almost disappeared.

In the past the Amu Darya played an important role in maintaining the fish stocks of the Aral Sea. Its floodplains, delta and lakes have created favorable conditions for natural reproduction of the major economic fish such as bream, carp and roach. In the Amu Darya and Syr Darya rivers the migratory Aral barbel (*Barbus brachycephalus*) and Aral sturgeon used to feed in the sea, migrate for spawning into rivers at distances of more than 1,000 km and return to the Aral Sea (Pavlovskaya L., 2005)[18].

In Soviet times, fish production largely focused on pond culture. The first fish-breeding farm was established on the Luchobka River in 1936 and Kuybyshev, the

[18] PAVLOVSKAYA L. (2005). Fishery in the lower Amu Darya under the impact of irrigated agriculture. www.fao.org/docrep/v9529e/v9529E04.htm

first hatchery was established at Vakhsh in Khatlon oblast in 1951 (Khaitov, 2008:7).

Originally covering 72 ha, the farm expanded within a period of 20 years to cover more than 200 ha and to produce 14 million larvae for domestic consumption and export purposes.

A hatchery and feeding ponds were developed in Kuybyshev in 1951, when the Vakhsh River changed course leaving a series of large ponds on its original watercourse. In 1988, a larvae reproduction complex was constructed at Kuybyshev with a projected capacity of 250 million units to supply all the former USSR's needs for herbivorous stock.

The favorable conditions for pond culture in Tajikistan saw a further ten fish-breeding installations open across the republic. Fish production reached its zenith in 1991 drawn from the newly constructed reservoirs in the north principally at Farkhadskiy, Kayrakkum and Katasey, and in the south at Nurek, expanded. In that year, pond culture which contributed 3,298 tons or 84% of the total fish production was largely focused on carp (silver and common carp comprised 94% of the catch) and smaller quantities of freshwater bream (130 tons).

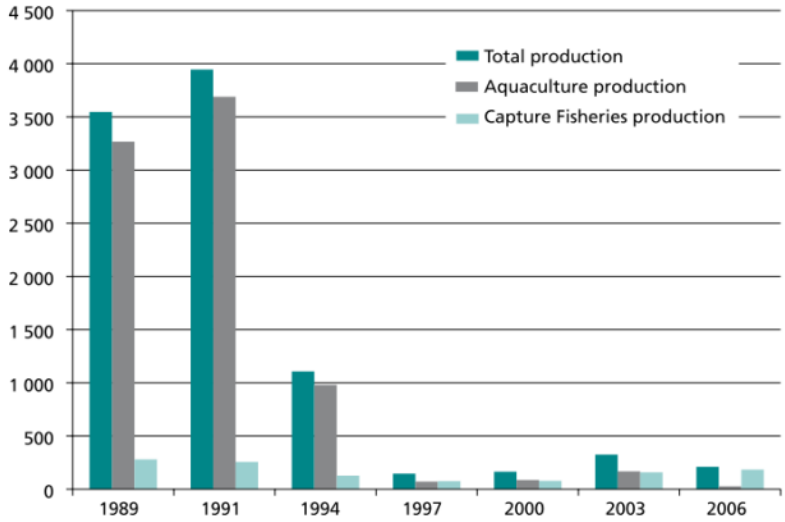
However, independence and the fracturing of economic links with the former Soviet bloc caused production to decline, the main reproduction unit being destroyed during the civil war.

Since 1991, however, there has been a swift decline in production (Figure 7). This decline has been attributed to three factors:

- Water pollution from industrial enterprises, agrochemical runoff and sewage;
- An increased incidence of illegal poaching; and
- Institutional failure, specifically the inability of post-independence institutions to guarantee a regular feed supply, to control fish diseases, and to adequately disinfect and/or maintain production facilities and/or restock effectively, factors in part related to the financial impoverishment of such institutions (Thorpe *et al.*, 2009)[19].

[19] Thorpe, A.; van Anrooy, R. Inland fisheries livelihoods in Central Asia: policy interventions and opportunities. FAO Fisheries and Aquaculture Technical Paper. No. 526. Rome, FAO. 2009. 61p.

Figure 44 - Fish production in Tajikistan, 1989-2006 (in tons)



The decision was taken to privatize the facility, and the hatchery and feeding ponds passed into the hands of the joint-stock company A. Djami in 2002/2003, which has since invested in the reconstruction of the reproduction facilities. The present enterprise covers 23 ponds (varying in size from 10 ha to 43 ha) and more than 600 ha (Thorpe *et al.*, 2009).

- **Current situation**

After the Aral Sea fishery ceased to exist, the fishery activities moved to lakes and reservoirs. Most of the water bodies have a low to medium productivity level. They are mostly shallow, of an average depth of 2-4 m, quick to warm up, rich in bottom plant detritus and aquatic macrophytes, with alkaline water o and no oxygen deficit. The water is usually saline, dominated by sulphates or sodium chlorides (Pavlovskaya L., 2005).

The fishery sector currently plays a minor role in development of the rural economy of Tajikistan. Its contribution to the country's Gross National Product was in recent years less than 0.1%. Despite the availability of extensive water resources (ponds, reservoirs, lakes, rivers and channels), fish production has fallen from 4,000 tons in 1991 to 214 tons in 2006 (Khaitov *et al.*, 2013)[20].

Fishing on the Amu-Darya is forbidden. Fishing is allowed only in the Tuyamuyun reservoir. There is widespread poaching especially downstream of the dam which has a major impact on fish stocks. The reservoir fishery is low-scale and has considerable potential for further development.

One of the serious problems facing the fish is the passive transport of the young from the river into irrigation systems. About 90% of the drifting young fish enter irrigation canals and perish on the irrigated fields (Pavlovskaya, 1982). Virtually none of the Amu-Darya irrigation uptakes has a fish protecting device. Those installed in the 1970s turned out to be ineffective. The other serious problem is the

[20] Khaitov, A.H., Gafurov, A., van Anrooy, R., Hasan, M.R., Bueno, P.B. and Yerli, S.V. 2013. Fisheries and aquaculture in Tajikistan: review and policy framework. FAO Fisheries and Aquaculture Circular. No. 1030/3. Ankara, FAO. 90 pp. www.fao.org/3/a-i3151e.pdf

preservation of the rare fish species which are disappearing from the modified water bodies.

4.4.3. Workplace safety

The assessment on occupational safety at Nurek HPP is based on the findings of the field visit to the HPP by the relevant staff of the consultant, which is experience in issues related HSE at hydropower plants.

What emerges from the visit and expertise is that if the basic rules are followed (wearing PPE, cleanliness of the installation, presence of physical protections such as guardrails, information via display, etc.). However, the equipment and facilities are aging, which generates new risks (lack of lighting for example).

Figure 45 – Photos from Nurek HPP (HSE issue)

Lack of lighting in Nurek HPP

Aging protection

Safety measures

The operation of the power plant is based on procedures that are applied methodologically and rigorously, but most of these procedures appear to date from the commissioning of the plant, that is at a time when HSE procedures were not as well developed as they are today (see international practices like IFC's *Workers' accommodation*). Therefore, there is room for improvement in the health and safety aspect.

4.5. Summary of significant environmental issues

This chapter summarizes all the significant environmental issues that have to be taken into account in the analyses of the impact of the project.

The level of each issue is based on its evaluation in terms of rarity, originality, diversity, protection, life quality, work quality.

The Table 11 hereafter lists the identified significant environmental issues from M01 to M16 linking them to the relevant study area (SA01 to SA04 as defined in section 4.1) and indicating the level of the issue: low moderate or high.

Table 14 - Significant issues of the environmental context of the project

Environmental components		Significant issues						
		Ref.	Description	Study area				Issue level
				SA01	SA02	SA03	SA04	
Physical - aquatic context	Hydrology	M01	Downstream hydrology of the Vakhsh river			X		High
	Hydrology	M02	Downstream hydrology of the Amu Darya river, until the Aral Sea (already impacted by the reduction of the water flow)			X		High
	Water Quality	M03	Water quality in the Vakhsh river (good compare to Amu Darya, but already modify by Nurek HPP)			X	X	High
Biological - terrestrial context	Protected area	M04	Tigrovaya Balka National Reserve presence in Tajikistan			X		High
	Protected area	M05	Amu Darya Reserve in Turkmenistan, and Kysylkum Protected Area and Badai Tugai in Uzbekistan			X		High
	Terrestrial fauna and flora	M06	Terrestrial fauna and flora conservation state	X	X	X	X	Low
Biological - aquatic context	Fish	M07	Fish population already impacted by Nurek HPP presence (upstream and downstream)			X	X	Moderate
Human	Housing area	M08	City and villages crossed by access road or in the vicinity of Nurek HPP (Nurek city)			X		Moderate
	Agriculture	M09	Agricultural water demand/need (especially cotton) in the downstream irrigated valleys			X		High
	Agriculture	M10	Agricultural water demand/need (especially cotton) in the downstream countries (Uzbekistan, etc.)			X		High
	Energy	M11	Nurek HPP energy production	X				High
	Energy	M12	Presence of several ROR HPP downstream Nurek HPP			X		High
	Energy	M13	Nurek HPP work environment (workers/operators health and safety)	X				High
	Fishery	M14	Fisheries			X		Moderate
	Domestic	M15	Domestic and industrial water use			X		Moderate
	Safety	M16	Downstream communities' safety			X		High

5. ENVIRONMENTAL IMPACT

5.1. Scope

At present, one of the primary objectives of sustainable development is to achieve economic development within the framework of plans which are compatible with the environmental principles and prevent renewable and non-renewable resources from destruction and depletion.
It is required to have macro and systematic views in this regard and to implement development infrastructures in conformity with environmental regulations to solve the environmental problems. The role of an EIA report is to identify the conditions for compliance with these requirements. In fact, the main purpose of this study is to ensure that the environmental regulations and principles have been taken into consideration. At present, the assessment of the impacts is considered as a device for making optimal decisions on the planning and management aspects with environmental viewpoints.

5.2. Methodology

Regarding the project characteristics in the environmental context and its main issues, the impacts of the project can be (i) identified and (ii) assessed.

The impacts are assessed with regards to:

- The project phase (*refurbishment* and *post-refurbishment/operation phases*);
- The environmental component (*physical*, *biological* or *human*). The definition of environmental components is comparable in different EIA but calibrated for each project, in view of the specific environmental issues of the site.

The impact assessment is performed in two steps:

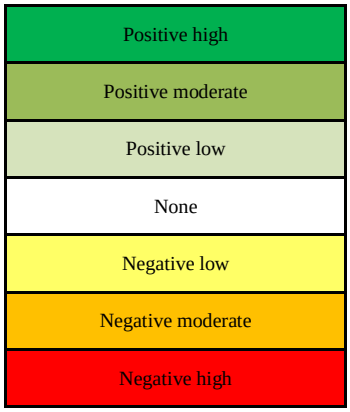
- *Identification* and *description* of impacts according to the environment component. An impact can be **positive** or **negative**.

- *Evaluation of the importance* of the impact depending on an analytical methodology that takes into account:
  - *Intensity*, it can be:
    - **Strong**: if the impact (i) affects a significant component of the environment (highly remarkable fauna population or flora species); (ii) affects a large area or number of species; (iii) causes disturbance of life conditions or environmental uses of communities leading to modification of the way of life or (iv) has important health and safety consequences;
    - **Medium**: if the impact (i) substantially disturbs an environmental component without compromising its use or its existence, (ii) affects a moderate number of species or moderate area without any remarkable issue (iii) disturbs life conditions of communities without endangering its way of life or (iv) has moderate health and safety consequences. The impact on the environment are significant but can be mitigated or compensated for by specific measures;

- **Low:** the impact (i) involves only minor changes in the affected component, (ii) affects only a limited number of specimens or (iii) does not have significant consequences for communities and workers.

- *Duration/frequency* of the impact can be:
  - **High:** when it, or its consequences, lasts throughout the project and can last beyond the duration of the project;
  - **Moderate:** when it happens occasionally during the project period;
  - **Low:** when it rarely occurs during the project period.

➔ The *impact importance* represents its final evaluation. The significance can be high, moderate or low.



Importance is calculated with the weighting or the duration, geographical scope and intensity of the impact.

Table 15 - Impact evaluation matrix

Intensity	Duration/frequency	Importance
Strong	High	**High**
	Moderate	**Moderate**
	Low	**Low**
Medium	High	**Moderate**
	Moderate	
	Low	**Low**
Low	High	**Moderate**
	Moderate	**Low**
	Low	

5.3. Impacts identification and evaluation

5.3.1. Impact n°I01: Vakhsh River's downstream flow regime modification

The impact of the project on the downstream flow regime is analyzed: (a) during the period of works when one unit is taken out of service for rehabilitation; and (b) after rehabilitation, when the available capacity of the power plant has been restored.

The operation rules and principles described in paragraph 3.1.5 (Current operating rules of Nurek HPP) remain in application during and after rehabilitation.

From the perspective of the downstream total discharge (power plant and spillways), the operating rules and principles imply the following during or after rehabilitation:

- **In winter:** energy production is limited by available water (low inflows + stored water). The discharge is controlled by the necessity of spreading out the usage of the stored water volume over the winter period. The power plant is therefore used far below its rated power capacity.
- **In summer:** high inflows are used for generation of electricity and to fill the reservoir. The filling of the reservoir is controlled by an operating rule for limiting the speed of filling. When the maximum daily filling is reached and the plant is functioning at full capacity, further inflows have to be evacuated through the spillways. In these circumstances, the rate of filling is controlled throughout the season in its upper limit by the limit of filling rate and in its lower limit by the necessity of having filled the reservoir at the end of September. The summer downstream discharge and its distribution from April to September remains therefore in these limits whatever the available capacity of the plant.

The impact is further analyzed in the following paragraphs:

a. During rehabilitation works

Considering the base case scenario where the units are taken out of service one at a time for rehabilitation, the works will start with Unit 8 which has been out of order since 2011. In this case, the power plant capacity will only increase throughout rehabilitation.

Therefore:

- During rehabilitation of Unit 8, in winter and summer, enough units remain available for energy generation. Rehabilitation of Unit 8, currently out of order, will not modify the current situation.
- In summer, when rehabilitation of the first unit is completed (Unit 8), the increase of available capacity allows an additional volume of water to be used for energy production, which would have otherwise been spilled. **Given the existing operation rules and principles to be respected, the total downstream discharge will not be impacted at a daily time-scale.**

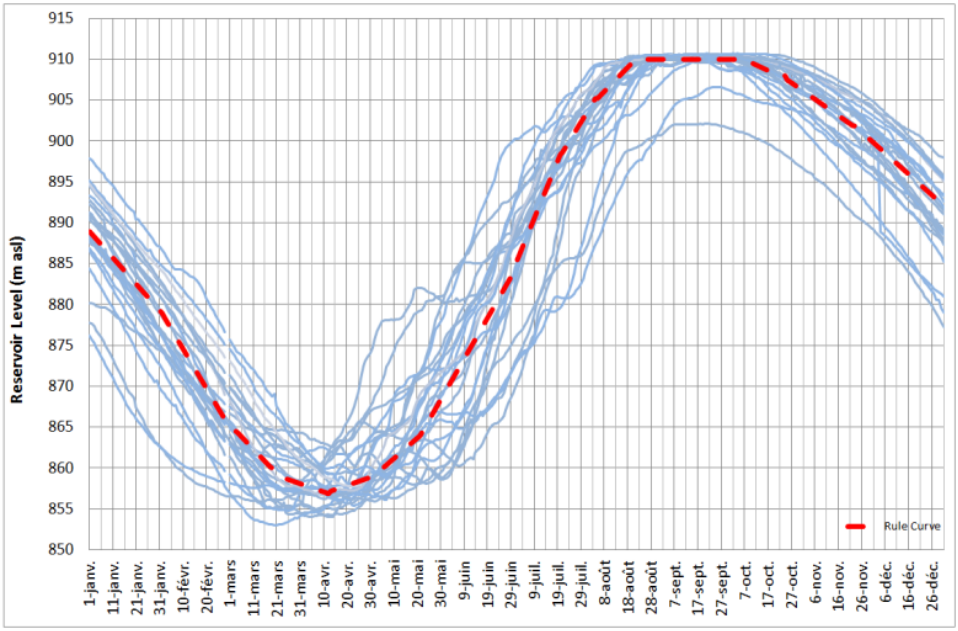
b. After rehabilitation

After rehabilitation, the powerplant capacity would have been increased to 3,015 MW, 3,116 MW or 3,214 MW.

In winter, as mentioned previously, the increased capacity will have no impact on energy production and, therefore, on downstream discharge since the limiting factor remains the available volume of water.

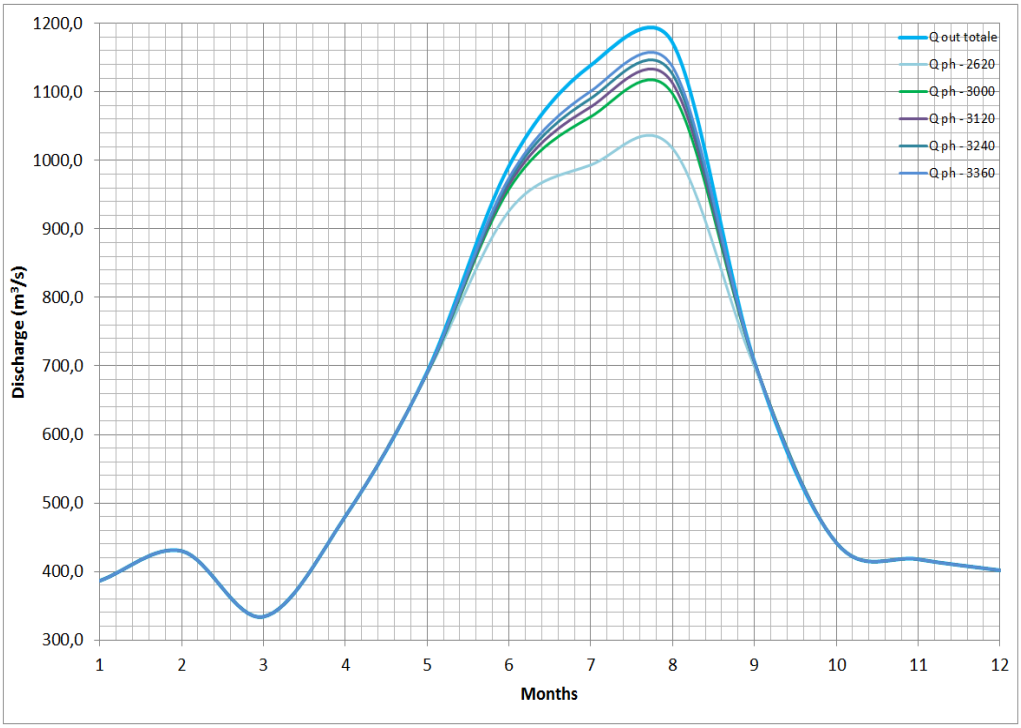
In summer, the increased capacity would allow an additional volume of water to be used for production, which would have otherwise been spilled. The total downstream discharge (power plant + spillways) is not impacted. To illustrate this, the energy generation with increased capacity is simulated using as input data the historic records of inflows (see Volume I Chapter 3 – Simulations of energy production for more details). The reservoir operation is considered following the red dotted curve in the following figure. This curve represents the standard reservoir operation in view of the records of reservoir level variations and in line with the existing operation rules and principles.

Figure 46 – Yearly records of evolution of the reservoir level over the period 1990-2013 and standard reservoir operation



The result of the simulation is plotted as the daily average discharge throughout the year. The total discharge and the powerhouse discharge are shown.

Figure 47 – Simulation of total downstream discharge and powerhouse discharge with various available power capacities



The simulations show that **the daily total discharge (from the powerhouse and the spillways) is the same for all installed capacities**. This is a direct result of using the same reservoir operation curve. Within this total discharge, the increase in capacity enables using more water for generation, thus, reducing the volume spilled.

c. Conclusion

It is shown that, given the existing operation rules and principles, during and after the refurbishment, **the project has no impact on the downstream discharge at a daily time-scale.**

Table 16 - Impact n°I01: Vakhsh River's downstream flow regime modification evaluation

Impact source	Impact		Evaluation			
			Nature	Intensity	Duration/ frequency	Importance
Hydro-electromechanical refurbishment	I01	Vakhsh's downstream flow regime modification (daily time step)	-	-	-	**None**

5.3.2. Impact n°I02: Nurek HPP reservoir management level modification

Regarding the explanation given in "Impact n°I01: Vakhsh River's downstream flow regime modification", **the reservoir level cannot be modified compared to the current situation.**

Table 17 - Impact n°I02: Nurek HPP reservoir management level modification evaluation

Impact source	Impact		Evaluation			
			Nature	ntensity	Duration/ frequency	Importance
Modification of the operating rules	I02	Nurek HPP reservoir management level modification during peak production in operation	-	-	-	**None**

5.3.3. Impact n°I03: Flood risk during refurbishment and operation

As presented in Chapter 4.2.1 "Flooding", the peak value for the inflows corresponding to the 10,000 year flood has been assessed at 5,690 m^3/s. This flood can be evacuated only if both spillways are opened and all 9 turbines are working.

Nevertheless, 2 turbines are currently not functioning: turbine 8 is off, and the cumulative malfunctioning of the eigth other turbines is equivalent to situation of having one turbine less. We can therefore conclude that **the current situation already represents a flood risk**.

As concluded previously (see Chapter 5.3.1), rehabilitation works will not introduce any changes to the water discharges (turbined + spillways). We can therefore conclude that in the situation when other turbines are subject to disturbance (in normal situations), **the refurbishment project will not generate any supplementary flood risk to the currently existing situation.**

Impact n°I11: Increase of the operational issues", a risk of involuntary shut-down of one or several turbines due to an electrical perturbation still exists.

During the operation of the dam, it can be assumed that the rehabilitation of the failing component of the turbines will increase the power supply capacity (due to increase of the turbine efficiency). However, this does not take into consideration the limiting factor of energy demand. Because the HPP cannot produce more than the demand, the total turbined water flow cannot be higher than it currently is.

Table 18 - Impact n°I03: Flood risk during refurbishment and operation evaluation

Impact source	Impact		Evaluation			
			Nature	Intensity	Duration/ frequency	Importance
Modification of the current discharge water capacity	03	Flood risk during refurbishment and operation	-	-	-	None

5.3.4. Impact n°I04: Refurbishment waste related risks

Waste is any solid, liquid, or contained gaseous material that is being discarded by disposal, recycling, burning or incineration. It can be a by-product of a manufacturing process or an obsolete commercial product that can no longer be used for intended purpose and requires disposal.

Non-hazardous waste, in this project, is solid. It will include inert construction / demolition materials; refuse, such as metal scrap and empty containers (except those previously used to contain hazardous materials which should, in principle, be managed as a hazardous waste). Waste can be recyclable and unrecyclable.

Hazardous waste shares the properties of hazardous materials, or other physical, chemical, or biological characteristics that may pose a potential risk to human health or the environment if improperly managed. Waste may also be defined as "hazardous" by local regulations or international conventions, based on the origin of the waste and its inclusion on hazardous waste lists, or based on its characteristics. They can be classified according to the hazard as explosives; compressed gases, including toxic or flammable gases; flammable liquids; flammable solids; oxidizing substances; toxic materials; radioactive material; and corrosive substances.

In this project hazardous wastes mainly includes: asbestos, oil contained in turbines or other devices of the power house. Moreover, other hazardous waste will be generated in small quantities: spent solvents and oily rags, empty paint cans, chemical containers; used lubricating oil. This waste should be managed following the guidance provided in the Environmental and Social Management Plan.

If these wastes are not dismantled, stocked, transported and treated/recycled in a proper way and process, spill, runoff and other accidental releases can occur.

This risk can occur during several refurbishment tasks:

- Turbine dismantling works (task T06);
- Generator dismantling work (task T07);
- Generator rehabilitation works (task T08);
- Turbine rehabilitation works (task T09).

This impact is evaluated as negative moderate.

Table 19 - Impact n°I04: Refurbishment waste evaluation

Impact source	Impact		Evaluation			
			Nature	Intensity	Duration/ frequency	Importance
Waste production	I04	Refurbishment waste pollution	Negative	Medium	High	**Moderate**

5.3.5. Impact n°I05: Water pollution risk

The project may have a direct downstream discharge of process wastewater containing chemical pollutants (impact n°I05.1).

Industrial wastewater generated from refurbishment operations includes wastewater from refurbishment operations, and runoff from process and materials staging areas. The pollutants in an industrial wastewater may include acids or bases (exhibited as low or high pH), soluble organic chemicals causing depletion of dissolved oxygen, suspended solids, nutrients (phosphorus, nitrogen), heavy metals (e.g. cadmium, chromium, copper, lead, mercury, nickel, zinc), cyanide, toxic organic chemicals, oily materials, and volatile materials.

This potential deterioration of water quality may lead to the **deterioration or loss of aquatic habitats and fauna** (fish, fisheries) in the vicinity of the dam (where habitat and aquatic fauna is supposed to be without issue), but also slightly downstream until pollutants are diluted by the Vakhsh River **(impact n°I05.2)**.

Given the remoteness of protected areas/areas of ecological interest (Tigrovaya Balka National Reserve, etc.), this impact will not influence them.

This risk can occur during several refurbishment tasks:

- Turbine dismantling works (task T06);
- Generator dismantling work (task T07);
- Generator rehabilitation works (task T08);
- Turbine rehabilitation works (task T09);
- Generator installation (task T10);
- Turbine installation (task T11).

Table 20 - Impact n°I05: Water pollution risk evaluation

Impact source	Impact		Evaluation			
			Nature	Intensity	Duration/ frequency	Importance
Waste production	I05.1	Water pollution risk	Negative	Medium	High	**Moderate**
Water pollution	I05.2	Potential downstream aquatic habitats and fauna perturbation	Negative	Medium	High	**Moderate**

5.3.6. Impact n°I06: Asbestos risks

Asbestos is a fibrous mineral commonly used as a component in many materials because of its strength and heat-resistance properties. It was widely used in a variety of building materials until 1987. All types of asbestos have been confirmed to cause cancer. Inhalation of asbestos fibers may result in asbestosis, a progressive fibrosis of lung tissue or mesothelioma. Diseases caused by asbestos may not manifest themselves for 15 to 50 years after exposure.

In the case of Nurek HPP, asbestos is present in the power station in sizeable quantity, including the generators (braking pads, stator insulation, rotor insulation), in some electrical equipment cubicles and in cable trays. The presence of such harmful material will require special precaution (see Chapter 9.4 “Mitigation measures”) with respect to workers’ health and safety.

During the refurbishment process, asbestos will be handled and stored representing a risk to human health and to the environment due to its physical and chemical characteristics.

This risk can occur during several refurbishment tasks:
- Turbine dismantling works (task T06);
- Generator dismantling work (task T07).

This impact is evaluated as negative high.

Table 21 - Impact n°I06: Asbestos risks evaluation

Impact source	Impact		Evaluation			
					Duration/ frequency	Importance
Waste production	I06	Asbestos removal and manipulation risks	Negative	Strong	High	**High**

5.3.7. Impact n°I07: Health and safety risks for workers

This chapter identifies and analyses the impacts of the project on workers, co-workers, and occasional visitors to the work place that may occur during the refurbishment project.

During refurbishment activities, physical hazards represent the potential for accidents, injury or illness due to repetitive exposure to mechanical action or work activity. Exposure to physical hazards may result in a wide range of injuries, from those requiring minor medical aid only, to those that can be disabling, catastrophic, and/or fatal. Multiple exposures over prolonged periods can result in disabling injuries of comparable significance and consequence.

Additionally, there will be risks to operating staff of Nurek HPP during rehabilitation because generating units will be rehabilitated while the power plant is operating. In other words, while one generating units is being rehabilitated by the Contractor's personnel, the Nurek HPP staff will need to continue routinely operating the other generating units located nearby. The larger than regular number of people in the power house may also crate health and safety risks due to limited space for Contractor's team working on refurbishment and Nurek HPP staff conducting regular operations. This risk will be mitigated through preparation and implementation of clear EHS plan, which will provide safe operation instructions for both the Contractor and Nurek HPP operations staff. Implementation of this plan will be supervised by PMC.

Preliminary remarks: The consultations raised the issue of magnetic fields as possible sources of disease, for communities as for HPP workers. According to international standards and organizations, there is no evidence of this. Here are the

explanations of the IFC's EHS Guideline for Electric Power Transmission and Distribution[21]:

"**Electric and Magnetic Fields**

"Electric and magnetic fields (EMF) are invisible lines of force emitted by and surrounding any electrical device (e.g. power lines and electrical equipment).

"Electric fields are produced by voltage and increase in strength as the voltage increases. Electric field strength is measured in volts per meter (V/m). Electric fields are shielded by materials that conduct electricity, and other materials, such as trees and building materials.

"Magnetic fields result from the flow of electric current and increase in strength as the current increases. Magnetic fields are measured in units of gauss (G) or tesla (T), where 1T equals 10,000G. Magnetic fields pass through most materials and are difficult to shield.

"Both electric and magnetic fields decrease rapidly with distance. Power frequency EMF typically has a frequency in the range of 50 – 60 Hertz (Hz), and is considered Extremely Low Frequency (ELF)[22].

"Although there is public and scientific concern over the potential health effects associated with exposure to EMF (not only high-voltage power lines and substations, but also from everyday household uses of electricity), there is no empirical data demonstrating adverse health effects from exposure to typical EMF levels from power transmissions lines and equipment.[23]"

Considering that the project does not change the current exposure of people to this type of field, **the ESIA does not consider EMF to be a risk to workers**. However, it will be possible to monitor this parameter in order to know the actual exposure to the fields in the factory and its immediate environment (see section 9.5.3.1).

- **Impact n°I07.1: Associated risks with rotating and moving equipment**

Injury or death can occur from being trapped, entangled, or struck by machinery parts due to unexpected starting of equipment or unexpected movement during operations.

This risk can occur during several refurbishment tasks:

- Turbine dismantling works (task T06);
- Generator dismantling work (task T07);
- Generator rehabilitation works (task T08);
- Turbine rehabilitation works (task T09).

This impact is evaluated as negative low.

[21] http://www.ifc.org/wps/wcm/connect/66b56e00488657eeb36af36a6515bb18/Final%2B-%2BElectric%2BTransmission%2Band%2BDistribution.pdf?MOD=AJPERES&id=1323162154847, 2007

[22] National Institute of Environmental Health Sciences (2002).

[23] International Commission on Non-Ionizing Radiation Protection(ICNIRP) (2001); International Agency for Research on Cancer (2002); U.S. National Institute of Health (2002); Advisory Group to the Radiation Protection Board of the UK (2001), and U.S. National Institute of Environmental Health Sciences (1999)).

Table 22 - Impact n°I07.1: Associated risks with rotating and moving equipment evaluation

Impact source	Impact		Evaluation			
			Nature	Intensity	Duration/ frequency	Importance
Working with or close to moving equipment	I07.1	Associated risks with rotating and moving equipment	Negative	Strong	Low	**Low**

- **Impact n°I07.2: Noise emission exposure risks**

The refurbishment work in a confined environment will lead workers to work in a noisy environment. As the turbine will be turned off, we can consider that the refurbishment activities will not increase the existing noise level, but workers will still have to face a noisy environment for several weeks.

This risk can occur during several refurbishment tasks:

- Turbine dismantling works (task T06);
- Generator dismantling work (task T07);
- Generator rehabilitation works (task T08);
- Turbine rehabilitation works (task T09).

This impact is evaluated as negative moderate.

Table 23 - Impact n°I07.2: Noise emission risks evaluation

Impact source	Impact		Evaluation			
			Nature	Intensity	Duration/ frequency	Importance
Noisy tasks	I07.2	Noise emission exposure risks	Negative	Medium	Moderate	**Moderate**

- **Impact n°I07.3: Electrical hazards**

Exposed or faulty electrical devices, such as circuit breakers panels, cables, cords and hand tools, can pose a serious risk to workers. Overhead wires can be struck by metal devices, such as poles or ladders, and by vehicles with metal booms. Vehicles or grounded metal objects brought into close proximity with overhead wires can result in arcing between the wires and the object, without actual contact.

This risk can occur during several refurbishment tasks:

- Turbine dismantling works (tasks T06);
- Generator dismantling work (tasks T07);
- Generator rehabilitation works (tasks T08);
- Turbine rehabilitation works (tasks T09);
- Generator installation (task T10);
- Turbine installation (task T11);

- Turbine and generator test (task T12).

This impact is evaluated as negative high.

Table 24 - Impact n°I07.3: Electrical hazards evaluation

Impact source	Impact		Evaluation			
			Nature	Intensity	Duration/ frequency	Importance
Work with or close to electrical equipment	I07.3	Electrical hazards risks	Negative	Strong	High	**High**

- **Impact n°I07.4: Welding / hot work hazards**

Welding creates an extremely bright and intense light that may seriously injure a worker's eyesight. In extreme cases, blindness may result. Additionally, welding may produce noxious fumes to which prolonged exposure can cause serious chronic diseases.

This risk can occur during several refurbishment tasks:

- Turbine dismantling works (task T06);
- Generator dismantling work (task T07);
- Generator rehabilitation works (task T08);
- Turbine rehabilitation works (task T09).

Table 25 - Impact n°I04.4: Welding / hot work hazards risks evaluation

Impact source	Impact		Evaluation			
			Nature	Intensity	Duration/ frequency	Importance
Hot work	I07.4	Welding / hot work hazards risks	Negative	Medium	Moderate	**Moderate**

- **Impact n°I07.5: On-site traffic risks**

Poorly trained or inexperienced industrial vehicle drivers can increase the risk of accidents with other vehicles, pedestrians, and equipment during the transport of components.

During the refurbishment, the dismantling and the storage of the components may modify the existing organization of Nurek HPP site. In this new configuration, industrial vehicles and delivery vehicles, as well as private vehicles on-site, may also represent potential collision scenarios.

We can say that this risk can occur throughout the duration of the project. Nevertheless, several refurbishment tasks will be more concerned:

- Mobilization at site (Task T03);
- Turbine dismantling works (task T06);
- Generator dismantling work (task T07);
- Generator rehabilitation works (task T08);
- Turbine rehabilitation works (task T09);

- Generator installation (task T10);
- Turbine installation (task T11).

This impact is evaluated as negative moderate.

Table 26 - Impact n°I07.5: On-site traffic risks evaluation

Impact source	Impact		Evaluation			
			Nature	Intensity	Duration/ frequency	Importance
Increase of vehicles and traffic in Nurek HPP area	I07.5	On-site traffic risk	Negative	Medium	Moderate	**Moderate**

- **Impact n°I07.6: Working at heights risks**

In several phases of this refurbishment project, workers will be required to work at heights and will be exposed to falling hazards.

This risk can occur during several refurbishment tasks:

- Turbine dismantling works (task T06);
- Generator dismantling work (task T07);
- Generator rehabilitation works (task T08);
- Turbine rehabilitation works (task T09).

This impact is evaluated as negative moderate.

Table 27 - Impact n°I07.6: Working at heights risks evaluation

Impact source	Impact		Evaluation			
			Nature	Intensity	Duration/ frequency	Importance
Work at a height	I07.6	Working at heights risk	Negative	Strong	Moderate	**Moderate**

5.3.8. Impact n°I08: Improvement of the health and safety work condition of the workers during operation

The rehabilitation of the Nurek HPP power house, the use of new devices including a new technology, modern control protection and monitoring system will lead to the **improvement of the health and safety work condition of the workers during operation.** In general, rehabilitation will provide workers a workplace with current Health, Safety & Environmental standards.

For example, in tunnel/galleries, the installation of proper aeration, lighting and railing for stairs will significantly reduce health and safety risks for workers. This impact is evaluated as positive moderate.

The rehabilitation project is a good opportunity for a **transfer of knowledge on Health and Safety** with contractors and international consultants. This transfer can be organized around the drafting of the Operation & Maintenance Manual of the power plant following World Bank guidelines.

Table 28 - Impact n°I08: Improvement of the health and safety work condition of the workers during operation evaluation

Impact source	Impact		Evaluation			
			Nature	Intensity	Duration/ frequency	Importance
Installation of proper aeration, lighting and railing for stairs	I08	Decrease of working health and safety risks in tunnels	Positive	Medium	High	**Moderate**

5.3.9. Impact n°I09: Health and safety risks for communities

This chapter provides additional impact analyses to the previous chapter, focusing on community health and safety impacts that may occur during and after the refurbishment project due to modification of current Nurek HPP characteristics (turbines operation, operating rules, energy production, etc.).

Preliminary remarks: The consultations raised the issue of magnetic fields as possible sources of disease, for communities and for HPP workers. According to international standards and organizations, there is no evidence of this (see section 0 for explanation). **The ESIA does not consider EMF to be a risk to local communities.**

In this chapter, given the location of refurbishment work in the power house (excluding transport activities), local people will not have access to the work areas and will therefore not be exposed to risks related to on-site refurbishment activities.

The health and safety risks/impacts for local communities are the following:

- **Impact n°I09.1: Exposition to potential water pollutions risk**

Oil, hazardous materials and others wastes generated by refurbishment works can be sources of water pollution if not managed properly, degrading surface and potentially subsurface water quality, given the significant duration (several months/year) of the project.

As described in a dedicated chapter (see Chapter 4.2.2), upstream of Nurek HPP, the Vakhsh River water quality is relatively good compared to the water quality of the Amu Darya River. Nevertheless, the Vakhsh River is characterized by a upstream to downstream degradation of water quality mainly related to salinity. Nurek HPP reservoir has contributed to the human-related impacts to the area and modification of the downstream water quality.

Water may be used for drinking, cooking, washing, and bathing. Thus water quality should comply with national acceptability standards or in their absence the current edition of WHO Drinking Water Guidelines.

Reduction of the water quality downstream Nurek HPP can occur throughout the duration of the project. Nevertheless, several refurbishment tasks/periods will be more concerned:

- Turbine dismantling works (task T06);
- Generator dismantling work (task T07);
- Generator rehabilitation works (task T08);
- Turbine rehabilitation works (task T09).

- Generator installation (task T10);
- Turbine installation (task T11).

This impact is evaluated as negative moderate.

Table 29 - Impact n°I09.1: Exposition to potential water pollution risks evaluation

Impact source	Impact		Evaluation			
			Nature	Intensity	Duration/ frequency	Importance
Waste production, spill, etc.	I09.1	Risk of exposition to water pollution	Negative	Medium	Moderate	**Moderate**

- **Impact n°I09.2: Traffic and pedestrian safety risks for communities**

The project will cause an increase in the number of vehicles to the area, including trucks, and an increase in traffic. The risk of collisions and bodily accidents involving workers or the local population will increase.

Traffic accidents will be the most significant causes of injuries and fatalities for communities and the main impact of the project on communities.

Traffic risks for communities can occur during:

- Mobilization at site (Task T03);
- Turbine main components purchase and transport (task 04);
- Generator main components purchase and transport (task 05).

This impact is evaluated as negative low.

Table 30 - Impact n°I09.2: Traffic and pedestrian safety risks for communities evaluation

Impact source	Impact		Evaluation			
			Nature	Intensity	Duration/ frequency	Importance
Increase of vehicles and traffic in the access road outside Nurek HPP	I09.2	Traffic and pedestrian safety risks for communities	Negative	Medium	Low	**Low**

- **Impact n°I09.3: Transport of Hazardous Materials and related risks for communities**

Risks related to the transport of hazardous waste like asbestos can be multiple: spill, fire, explosion, leakage, loss, theft, etc.

Transport of Hazardous Materials risks for communities can occur during:

- Mobilization at site (Task T03);
- Turbine main components purchase and transport (task T04);
- Generator main components purchase and transport (task T05).

This impact is evaluated as negative moderate.

Table 31 - Impact n°I09.3: Transport of Hazardous Materials and related risks for communities evaluation

Impact source	Impact		Evaluation			
			Nature	Intensity	Duration/ frequency	Importance
Transport of Hazardous Materials	I09.3	Transport of Hazardous Materials and risks for communities	Negative	Strong	Moderate	**Moderate**

5.3.10. Impact n°I10: Dam safety improvement

With the implementation of recommendations related to dam safety based on inspections (see Chapter 3.2.6), **dam safety will be improved** by the improvement of various safety tasks:

- The collection, the secure access to, and the organization of documentation and data regarding safety monitoring;
- Rehabilitation of spillway tunnels, refurbishment of spillway gates/hoisting system, improvement of protection on permeable zone of the embankment dam above the core zone crest;
- Introduction of an advanced flood forecasting/warning system and preparing optimized reservoir operating rules to enhance the flood-handling capacity of the dam;
- Refurbishment and upgrade of monitoring instruments and management system to improve the collection and analysis of the safety monitoring data;
- Update of the Emergency Preparedness Plan (EPP), Operation and Maintenance Plan (O&M), and the Instrumentation Plan.

Table 32 - Impact n°I10: Dam safety improvement evaluation

Impact source	Impact		Evaluation			
			Nature	Intensity	Duration/ frequency	Importance
Implementation of recommendations	I10	Dam safety improvement	Positive	Strong	High	**High**

5.3.11. Impact n°I11: Increase of the operational issues

During rehabilitation works, **errors in work procedure may cause the stoppage of one or several other units**. This kind of event can occur when working in interface zones of two or more units. Depending on the event, this stoppage can last several hours.

Such event will **temporarily reduce the spillage capacity at Nurek**. However, as regards protection against floods, the loss in spillage capacity (some units during less than a day) is negligible compared to the volume of water to be routed during a flood event. Furthermore, Nurek remains protected using the evacuation capacity of the two independent spillways.

Such event can also lead to an **electrical production impact** (Impact n°I11.2) with **a reduction of electrical production** and **an energetic fluctuation (tension) in the electricity grid**.

These impacts can occur during several refurbishment tasks/periods:

- Turbine dismantling works (task T06);
- Generator dismantling work (task T07);
- Generator rehabilitation works (task T08);
- Turbine rehabilitation works (task T09);
- Generator installation (task T10);
- Turbine installation (task T11);
- Turbine and generator test (task T12).

If not specific measure is implementing (in particular a "work permit" procedure), such event could occur frequently during the course of the Project.

Table 33 - Impact n°I11: Increase of the operational issues evaluation

Impact source	Impact		Evaluation			
			Nature	Intensity	Duration/ frequency	Importance
Involuntary stoppage of one or several units due to issue in refurbishment works	I11.1	Temporary reduction of spillage capacity	Negative	Low	High	**Low**
Involuntary stoppage of one or several units due to issue in refurbishment works	I11.2	Electrical production impacts	Negative	Strong	High	**High**

5.3.12. Impact n°I12: Socio-economical perturbations and benefits

Various **socio-economical changes** (Impact n°I12.1) may happen upon the arrival of additional workers (increase in hotel prices, tension between local and foreign populations, etc.). Nevertheless, due to the size of Nurek city and the limited number of workers needed for the project, these impacts will be low to negligible.

The project can also entail some positive impacts:

- **Job opportunities for the local population** (Impact n°I12.2). Since the project will be completed over a period of more than 10 years, with only one unit rehabilitated at a time, the maximum number of workers is expected to be around 100, with a significant number of skilled jobs (welders, electricians, etc.).

  The procedures for workers' selection, including priority criteria, will be developed by the Contractor in consultation with the BT and, when appropriate, with the Authorities. It could include, for example, that:

- Given the same qualification, the contractors will be encouraged to give priority for recruitment to local population.
- Local inhabitants do not only get jobs as unqualified labor, but should be considered for qualified jobs.

- **Development of economic opportunities**, e.g. for hotels, trade, etc. (Impact n°I12.3).

These impacts are not specific to a task but can happen throughout the project.

5.3.13. Impact n°I13: Climate risk assessment

Effects of Nurek Reservoir on local climate

Regarding the explanation given in "Impact n°I01: Vakhsh River's downstream flow regime modification", the reservoir level cannot be modified, compared to the current situation. Therefore, there will be no impacts on the local climate.

Climate change and its effects on Nurek HPP

Climate change is likely to influence water availability in the future and can or will therefore have impacts on the uses of water resources, hydropower amongst others. For Central Asia and therefore the situation of Nurek HPP the following main effects can be expected:

- Mean air temperature will rise and this will increase evapotranspiration.
- Mean annual precipitation will remain unchanged, but variability from year to year is likely to increase.
- Runoff of many rivers will increase due to the melting of glaciers until about 2080, and will then decrease.
- Higher temperatures and the retreat of glaciers will lead to an upward shift of permafrost, which can mobilize large amount of glacier sediments, increasing the sediment load in rivers.
- Peak flows in rivers will tend to occur earlier in the year due to more precipitation falling as rain instead of as snow, and due to earlier snow melt.
- Variability of flows from year to year, and therefore cases of dryer and wetter than average years, is likely to increase.

The information gathered from the various sources is not sufficient to forecast changes in reservoir temperature and the resulting stratification / mixing behavior due to change of average ambient temperature as well as the water temperature of the Vakhsh River and other direct inflows or impacts on reservoir water chemistry, fauna and flora as these changes cannot be modeled by the available projection tools.

5.3.14. Summary of the project impacts

In total, the project leads to 23 impacts, 19 are negative and 4 positive.

The majority of impacts concern (i) pollution due to refurbishment wastes (hazardous and non-hazardous), (ii) health and safety risks that may affect workers, and communities, (iii) Nurek HPP safety.

No impacts have been identified regarding water demand/use downstream Nurek HPP.

A total of 3 negative impacts “high” were identified, 2 of them refer to the working conditions of workers and operators (Asbestos removal and manipulation risks and Electrical hazards risks) and 1 refers to electrical production perturbation due to the risk of turbine shut-down during refurbishment. Other negative impacts are mostly “moderate”.

The “high” positive impact is related to dam safety improvement and the energy production.

Table 34 - Summary of the project impacts

Environmental component		Impact										
		Ref.	Source	Type	Description	Concerned study area				Project phase		Importance
						SA01	SA02	SA03	SA04	Refurbishment *(concerned tasks)*	Operation	
Physical - terrestrial context	Hydrology	I01	Hydro-electromechanical refurbishment	-	Vakhsh River's downstream flow regime modification							None
	Reservoir water level	I02	Modification of the operating rules	-	Nurek HPP reservoir management level modification							None
	Soil, water surface quality	I04	Waste production	Negative	Refurbishment waste pollution	x				x (T06, T07, T08, T09)		Moderate
		I06	Waste production	Negative	Asbestos removal and manipulation risks					x (T06, T07)		High
Physical - aquatic context	Water Quality	I05.1	Waste pollution	Negative	Water pollution risk			x		x (T06, T07, T08, T09, T10, T11)		Moderate
Physical – climate context	Climate risk	I13	Reservoir	-	Effects of Nurek Reservoir on local climate							None
Biological context	Aquatic habitats and fauna	I05.2	Water pollution	Negative	Potential downstream aquatic habitats and fauna perturbation			x		x (T06, T07, T08, T09, T10, T11)		Moderate
Human	Health and safety - workers	I06	Waste production	Negative	Asbestos removal and manipulation risks	x				x (T06, T07)		High
		I07.1	Working with or close to moving equipment	Negative	Associated risks with rotating and moving equipment	x				x (T06, T07, T08, T09)		Low
		I07.2	Noisy tasks	Negative	Noise emission exposure risks	x				x (T06, T07, T08, T09)		Moderate
		I07.3	Work with or close to electrical equipment	Negative	Electrical hazards risks	x				x (T06, T07, T08, T09, T10, T11, T12)		High
		I07.4	Hot work	Negative	Welding / hot work hazards risks	x				x (T06, T07, T08, T09)		Moderate
		I07.5	Increase of vehicles and traffic in Nurek HPP area	Negative	On-site traffic risk	x				x (T03, T06, T07, T08, T09, T10, T11)		Moderate
		I07.6	Work at a height	Negative	Working at heights risk	x				x (T06, T07, T08, T09)		Moderate
		I08	Installation of proper aeration, lighting and railing for stairs	Positive	Decrease of working health and safety risks in tunnels	x					x	Moderate

Environmental component		Impact										
		Ref.	Source	Type	Description	Concerned study area				Project phase		Importance
						SA01	SA02	SA03	SA04	Refurbishment *(concerned tasks)*	Operation	
	Health and safety - communities	I09.1	Waste production, spill, etc.	Negative	Risk of exposition to water pollution			x		x (T06, T07, T08, T09, T10, T11)		Moderate
		I09.2	Increase of vehicles and traffic in the access road outside Nurek HPP	Negative	Traffic and pedestrian safety risks for communities		x			x (T03, T04, T05)		Low
		I09.3	Transport of Hazardous Materials	Negative	Transport of Hazardous Materials and risks for communities		x			x (T03, T04, T05)		Moderate
	Production of energy	I11.2	Involuntary stoppage of one or several units due to issue in refurbishment works	Negative	Electrical production impacts	x				x (T06, T07, T08, T09, T10, T11, T12)		High
	Dam safety	I03	Modification of the current discharge water capacity	-	Flood risk during refurbishment and operation							None
		I10	Implementation of recommendations	Positive	Dam safety improvement	x		x	x		x	High
		I11.1	Involuntary stoppage of one or several units due to issue in refurbishment works	Negative	Temporary reduction of spillage capacity	x		x		x (T06, T07, T08, T09, T10, T11, T12)		Low
	Socio-economic local conditions	I12.1	Arrival of workers	Negative	Socio-economic tensions			x	x	x		Low
		I12.2		Positive	Job opportunities for local populations			x	x	x		Low
		I12.3		Positive	Development of economic opportunities			x	x	x		Low

The project does not impact all identified significant environmental issues (see Table 14). Indeed, of the 16 main issues identified for the environment (physical, biological and human) into which the project fits, 9 will be impacted.

Table 35 - Affected and non-affected environmental issues

Affected issues		Non-affected issues	
M03	Water quality in the Vakhsh River (good compare to Amu Darya, but already modify by Nurek HPP)	M01	Downstream hydrology of the Vakhsh River
M06	Terrestrial fauna and flora conservation state	M02	Downstream hydrology of the Amu Darya river, until the Aral Sea (already impacted by the reduction of the water flow)
M07	Fish population already impacted by Nurek HPP presence (upstream and downstream)	M04	Tigrovaya Balka National Reserve presence in Tajikistan
M08	City and villages crossed by access road or in the vicinity of Nurek HPP (Nurek city)	M05	Amu Darya Reserve in Turkmenistan, and Kysylkum Protected Area and Badai Tugai in Uzbekistan
M11	Nurek HPP energy production	M09	Agricultural water demand/need (especially cotton) in the downstream irrigated valleys
M13	Nurek HPP work environment	M10	Agricultural water demand/need (especially cotton) in the downstream countries (Uzbekistan, etc.)
M14	Fisheries	M12	Presence of several ROR HPP downstream Nurek HPP
M15	Domestic and industrial water use		
M16	Downstream communities' safety		

Most impacts affect only one issue. Nevertheless, it is not impossible that some impacts may affect more than one issue.

Table 36 - Impacts of the projects and environmental issues

Environmental component		Issues			Impact																		
					I04	I05.1	I05.2	I06	I07.1	I07.2	I07.3	I07.4	I07.5	I07.6	I08	I09.1	I09.2	I09.3	I10	I11.1	I11.2	I12.1	I12.2	I12.3
					Negative	Negative	Negative	Negative	Negative	Negative	Negative	Negative	Negative	Negative	Positive	Negative	Negative	Negative	Positive	Negative	Negative	Negative	Positive	Positive
		Ref.	Description	Issue level	Refurbishment waste pollution	Water pollution risk	Potential downstream aquatic habitats and fauna perturbation	Asbestos removal and manipulation risks	Associated risks with rotating and moving equipment	Noise emission exposure risks	Electrical hazards risks	Welding / hot work hazards risks	On-site traffic risk	Working at heights risk	Decrease of working health and safety risks in tunnels	Risk of exposition to water pollution	Traffic and pedestrian safety risks for communities	Transport of Hazardous Materials and risks for communities	Dam safety improvement	Temporary reduction of spillage capacity	Electrical production impacts	Socio-economic tensions	Job opportunities for local populations	Development of economic opportunities
					Moderate	Moderate	Moderate	High	Low	Moderate	High	Moderate	Moderate	Moderate	Moderate	Moderate	Low	Moderate	High	Low	High	Low	Low	Low
Physical - aquatic context	Hydrology	M01	Downstream hydrology of the Vakhsh river	Highs	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Hydrology	M02	Downstream hydrology of the Amu Darya river, until the Aral Sea (already impacted by the reduction of the water flow)	High	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Water Quality	M03	Water quality in the Vakhsh river (good compare to Amu Darya, but already modify by Nurek HPP)	High	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Biological - terrestrial context	Protected area	M04	Tigrovaya Balka National Reserve presence in Tajikistan	High	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Protected area	M05	Amu Darya Reserve in Turkmenistan, and Kysylkum Protected Area and Badai Tugai in Uzbekistan	High	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Terrestrial fauna and flora	M06	Terrestrial fauna and flora conservation state	Weak	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Biological - aquatic context	Fish	M07	Fish population already impacted by Nurek HPP presence (upstream and downstream)	Moderate	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Human	Housing area	M08	City and villages crossed by access road or in the vicinity of Nurek HPP (Nurek city)	Moderate	-	-	-	-	-	-	-	-	-	-	-	-	X	X	X	-	-	X	X	X
	Agriculture	M09	Agricultural water demand/need (especially cotton) in the downstream irrigated valleys	High	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Agriculture	M10	Agricultural water demand/need (especially cotton) in the downstream countries (Uzbekistan, etc.)	High	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Energy	M11	Nurek HPP energy production	High	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-
	Energy	M12	Presence of several ROR HPP downstream Nurek HPP	High	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Energy	M13	Nurek HPP work environment	High	-	-	-	X	X	X	X	X	X	X	X	-	-	-	X	-	-	-	-	-
	Fishery	M14	Fisheries	Moderate	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Domectic	M15	Domestic, agricultural and industrial water uses	Moderate	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-
	Safety	M16	Downstream communities' safety	High	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	X	-	-	-	-

6. RAPID CUMULATIVE IMPACTS ASSESSMENT

6.1. Objectives

This RCIA has a goal of identifying: (i) issues that the Nurek refurbishment project, when placed in the context of existing and planned developments in the future, may generate; or (ii) cumulative effects initiated by the Nurek refurbishment project that could jeopardize the overall long term environmental, social and economic sustainability of the watershed.

6.2. Scoping: Boundaries Definition

6.2.1. Geographical Boundary

The logical **geographical boundary** of the RCIA would be the whole Vakhsh watershed until its confluence point with the Amu Darya. But, as the Nurek dam belongs to a cascade of dams, in the first instance it is relevant to confine the analysis to the section of the Vakhsh between the Rogun HPP site, upstream, and the Baipasa HPP, downstream.

6.2.2. Temporal Boundary

The environmental impact assessment of the Nurek refurbishment project has demonstrated that there is no negative impact during the operation and maintenance phase (see Table 34). Thus, the chosen temporal boundary of the RCIA is the refurbishment project implementation phase.

6.2.3. Impacts of Rogun HPP on Downstream Water Releases

The Government's intent is to fill the Rogun reservoir using part of the share allocated to Tajikistan under current agreements and practices. Assuming that this situation would continue to prevail until the end of the reservoir filling period, this hitherto unused share would be sufficient to fill the reservoir. As per the TEAS report, reservoir filling is expected to take 16 years. For the operational phase of the Rogun project, it is the Government’s intent to limit the transfer of water from the vegetative season inflows at Rogun to the non-vegetative season releases downstream of Nurek to 4.2 km³, which is the quantity currently transferred by the operation of the Nurek reservoir utilizing its present live storage capacity. The TEAS simulations are based upon this operating regime, which would not change the current downstream flow pattern.

The technical and environmental studies demonstrate that it is possible to operate the Vakhsh cascade with Rogun in a way that the river flow pattern downstream of the cascade will remain unchanged.

6.3. Selection of Valued Environmental and Social Components

The Table 34 shows that, considering the distance between Nurek and Rogun (upstream) or Baipasa (downstream) HPP, most negative impacts generated by the Nurek refurbishment project will remain site-specific; no cumulative impact is then expected for these Nurek impacts. Especially, impacts regarding:

- "Soil, water surface quality" (I04);
- "Health and safety – workers" (I06 to I07.6)

belong to this category.

Besides, Table 37 (extract from Table 35) shows that only 9 environmental issues are affected by the Nurek refurbishment project.

Table 37 - Affected environmental issues

Affected issues			
M03	Water quality in the Vakhsh River (good compared to Amu Darya, but already modified by Nurek HPP)	M13	Nurek HPP work environment
M06	Terrestrial fauna and flora conservation state	M14	Fisheries
M07	Fish population already impacted by Nurek HPP presence (upstream and downstream)	M15	Domestic and industrial water use
M08	City and villages crossed by access road or in the vicinity of Nurek HPP (Nurek city)	M16	Downstream communities' safety
M11	Nurek HPP energy production		

For this RCIA, the above remaining impacts and environmental issues are combined as shown in the following table. The corresponding Valued Environmental and social Components (VECs) are assessed for cumulative impacts in continuation.

6.4. Cumulative Impact Assessment Over Selected VECs

6.4.1. Water quality

Considering the Nurek refurbishment project, the water quality could be affected by water pollution due to a discharge of process wastewater containing chemical pollutants. From the larger point of view of the geographical boundaries of this RCIA:

- This would only affect the downstream part of the river;
- It is highly unlikely that such a pollution:
  - Will be sufficient to affect the Vakhsh down to the Baipasa HPP included,
  - Will occur simultaneously with an upstream or downstream pollution of the same kind.

As a result, a cumulative impact over the water quality is considered highly improbable.

6.4.2. Housing area – City and villages crossed by access road or in the vicinity of Nurek HPP

This VEC can be affected by the Nurek refurbishment project in multiple ways:

- Traffic and pedestrian safety risks for communities;
- Transport of Hazardous Materials and risks for communities ;
- Socio-economic tensions.

From the larger point of view of the geographical boundary of this RCIA, the Rogun project does not involve the same roads besides the stretch of four-lane road from Dushanbe to Vahdat. Also the project does not involve the same communities.

As a result, a cumulative impact over the housing area is considered improbable.

Table 38 - Impacts of the Nurek refurbishment project and environmental issues

Environmental component		Issues			Impacts							
					I05.1	I05.2	I09.1	I09.2	I09.3	I11.1	I11.2	I12.1
					Negative	Negative	Negative	Negative	Negative	Negative	Negative	Negative
		Ref.	Description	Issue level	Water pollution risk	Potential downstream aquatic habitats and fauna perturbation	Risk of exposition to water pollution	Traffic and pedestrian safety risks for communities	Transport of Hazardous Materials and risks for communities	Temporary reduction of spillage capacity	Electrical production impacts	Socio-economic tensions
					Moderate	Moderate	Moderate	Low	Moderate	Low	High	Low
Physical - aquatic context	Water Quality	M03	Water quality in the Vakhsh river (good compared to Amu Darya, but already modified by Nurek HPP)	**High**	x	-	-	-	-	-	-	-
Human	Housing area	M08	City and villages crossed by access road or in the vicinity of Nurek HPP (Nurek city)	**Moderate**	-	-	-	x	x	-	-	x
	Energy	M11	Nurek HPP energy production	**High**	-	-	-	-	-		x	-
	Fishery	M14	Fisheries	**Moderate**	-	x	-	-	-	-	-	-
	Domestic	M15	Domestic, agricultural and industrial water uses	**Moderate**	-	-	x	-	-	-	-	-
	Safety	M16	Downstream communities' safety	**High**	-	-	-	-	-	x	-	-

6.4.3. Energy production

This VEC can be affected by energy fluctuation on the electrical grid due to involuntary stoppage of one or several units at Nurek HPP due to issues during refurbishment works, in particular when working on elements of the balance of plant common to various units.

Cumulated impacts in terms of energy fluctuation on the network may occur in the following scenarios:

- Occurrence of an involuntary shutdown in another source of the network, but it is highly improbable that both events would be concomitant
- Specific operations are carried out in another source of the network which induce energy fluctuations: for example the commissioning of the Rogun turbines for Early Generation. However such operation will be performed in full coordination with the network operator. The risk of cumulated impact may therefore be mitigated by avoiding that refurbishment works on common parts of the powerhouse at Nurek be carried out at the same time as the commissioning phase at Rogun (in this example). To this effect, the work permit procedure (see section 9.4.4) shall require coordination with the network operator for activities identified as presenting a risk of involuntary shutdown at Nurek.

Cumulative impacts on energy production are therefore improbable provided the above coordination measures be implemented.

6.4.4. Fisheries

This VEC can be affected by the Nurek refurbishment project due to downstream aquatic habitats and fauna perturbation generated by water pollution.

As already seen in § 6.4.1, as a cumulative impact over the water quality is considered highly improbable, such is a cumulative impact over fisheries.

6.4.5. Domestic, agricultural and industrial water uses

This VEC can be affected by the Nurek refurbishment project due to a risk of exposition to water pollution.

As already seen in § 6.4.1, as a cumulative impact over the water quality is considered highly improbable, such is a cumulative impact over the domestic, agricultural and industrial water uses.

6.4.6. Downstream communities' safety

As regards this VEC, it has been highlighted that an involuntary shutdown of one or several units due to issues during refurbishment works would induce temporarily a reduction of the Nurek spillage capacity. However as regards protection against floods, this loss in spillage capacity (some units during less than a day) is negligible compared to the volume of water to be routed during a flood event. Furthermore, Nurek remains protected using the evacuation capacity of the two independent spillways.

Therefore no cumulated impact is identified as regards downstream communities' safety.

6.5. Conclusion

In outcome of the Rapid Cumulative Impact Assessment, no cumulative impact on has been identified on the selected Valued Environmental and social Components (VECs).

7. CONSULTATIONS

7.1. Objectives

This section outlines the consultations undertaken on the draft ESIA. SEP that outlines future consultations is summarized in section 9 and detailed in Appendix 3.

Consultations were undertaken on the draft ESIA. The objectives were to provide information, obtain reactions and feedback to the environmental and social impacts and related issues of the Nurek Hydropower Plant Rehabilitation Project as identified in the ESIA report. The objective was also for the public to receive reliable information on the goals and the content of social and environmental consultations and for it to have a chance to comment on these documents.

The consultation was conducted by the Public Organization Kuhiston, on behalf of Barki Tajik, in accordance with the WB procedures and the requirements of the national regulations for a project of this importance.

The project details were also shared with the riparians as per requirement of the World Bank OP7.50. Specifically, at the request of the Government of Tajikistan, the World Bank sent a letter, dated December 12, 2016, signed by the Country Director for Central Asia. The letter contains description of the project development objective, project components, estimated cost of the project, and key conclusions from the ESIA regarding the downstream water releases.

7.2. Methodology

The first step was to identify the stakeholders for the project. It was based on the Stakeholder Consultation and Information Disclosure Plan (SCIDP), now referred to as the SEP, developed in the draft ESIA (section **Error! Reference source not ound.**). Results are presented in the below section.

The second step was to organize the consultations which were carried out in the form of meetings at the national, regional and local levels. The process is fully described in the Consultations Report in Appendix 4. The consultations were informed by a stakeholder mapping which identified key stakeholders at the national, regional, and local lvels.

The consultations involved:

- An administrative procedure;
- The preparation of an agenda (time and location for the consultations) and of presentation materials (leaflets) in Tajik and Russian;
- A wide public information dissemination through different channels (letters, jamoats and mahalla heads).

The schedule of consultations is shown in Table 39.

Results of the consultations are gathered and summarized in section 7.3.

Table 39 – Actual consultations timetable

Stakeholder	Level (location)	Number of meetings	Actual number of participants		Date of conducting
			Total	Including women	
Ministries, Agencies, State Committees etc. and national-level CSOs and NGOs, including environment-focused and forestry	National (Dushanbe)	1	16	8	08.07.2016
Khatlon Region Authorities, representatives, including women groups, farmers associations, WUAs, NGO/CSOs	Regional (Kurgan-Tyube City municipality hall)	1	38	14	21.06.2016
Jilikul, including administration of the natural reserve "Tigrovaya Balka", etc.	Regional (District community hall)	1	34	16	22.06.2016
Nurek City and Dukoni jamoat	Local (Nurek city library hall)	1	54	39	23.06.2016
Puli Sangin jamoat	Local (Community hall)	1	33	8	23.06.2016
Total		5	175	85	-

7.3. Outputs of the consultancy process

7.3.1. Stakeholders' map

7.3.1.1. NATIONAL LEVEL

Table 40 details all identified stakeholders at national level.

Table 40 – Stakeholders at national level

Stakeholder / sub-group	Relevant functions	Role in the project	Power / influence	Perception of process / impacts
Ministry of Energy and Water resources (MEWR)	* Regulates legal norms in the field of fuel power production, natural resources, including renewable energy sources in the industry, technical and technological field, construction industry, in the food and food processing industry; * Coordination, management and supervisory over relevant state services, State energy sector control service, and other organizations and enterprises under the Ministry.	Regulatory and coordinating role	High power	High interest in the project and its impacts
OJSHC Barqi Tojik	* Production transportation, transmission, distribution and sale of electrical and heat power energy mainly on the local market of the country; * Deals with issues of country's power stations and grids operation, generation, transmission, distribution and sale of electrical and heat power energy mainly on the local market of the country; * OJSHC "Barqi Tojik" is, as entrusted by the Government of the RT, the major shareholder of the joint-stock companies in the energy sector, has the right to own, use and disposal of property of the enterprises and entities under its management; * Includes 24 joint-stock energy objects, including, Nurek HPP. Employs over 12,000 persons.	Owns Nurek HPP and the Project	High power and influence	High interest in the project
Nurek HPP	* Produces country's 70% electrical energy; * Is an Open Joint stock Company managed by Barqi Tojik	Key beneficiary of the Project	High power and influence	High interest in improving its operation
Committee on Environment Protection (CEP)	* Supervision over environment protection and environmental planning and compliance; * Drafting and implementation of scientific and technical policies in the area of environment protection; * State control over protecting lands, surface and ground water, air, flora and fauna, fishery resources.	CEP performs an independent functions, mainly through monitoring, supervision, approval and authorization of actions within the subdivisions; Clearing the ESIA/EIA	High in providing clearance of ESIA	High interest in environmental impacts of the Project
State	Has the following responsibilities in the area of investment and foreign aid:	Conducts bids and	Power	High interest in

Stakeholder / sub-group	Relevant functions	Role in the project	Power / influence	Perception of process / impacts
Investment and State Property Management Committee	* Develop and implement measures aimed at improving the country's investment climate setting up legal and other provisions promoting investments; * Take part in developing and implementing investment programs; * Promote foreign investments for implementation of State programs and priority social projects, including international loans and grants; * General coordination of aid mobilization, management and monitoring process, ensures implementation of plans and activities provided in the programs and strategies for mobilization, management and monitoring of foreign aid; * Participates in drafting and concluding international agreements on investments in cooperation with other relevant ministries and agencies; * Collaborates with interested agencies on accounting and records related to mobilization and management of investment and all types of external aid; * Facilitates and manages appraisals of contracts and other documents related to investment projects; * Ensures that all authorizations and permissions necessary for project implementation are in place; * Monitors and controls implementation of investment projects and provisions of the contracts; * Takes steps to ensure transparency, fairness and effectiveness of procurement of goods, works and services in the context of State Investment Projects; * Organizes bid opening procedures for tenders on procurement of goods, works and services in the context of State Investment Projects; * Monitors procurement activities in project coordination units (PIUs/PMUs)	tender openings for goods, works and services; monitors procurement; participates during loan negotiations etc.	low/influence might be high due to risk of delayed tendering/bid opening procedures and/or procurement	the project due to its strategic priority
Ministry of Health and Social Protection of Population (MHSPP)	* Is key executive government body, responsible for drafting and implementing state policy and regulating legal norms of the activity in the field of healthcare and social protection of the population; * Endorses the order for managing statistical reporting in the health and social protection sector; * Caries out sanitary and epidemiological surveillance;	Sanitary and Epidemiological Service (SES) will be monitoring and controlling infectious diseases trend, including	High power and influence	Interest in Project and its impact high (with regards EMP implementation

Stakeholder / sub-group	Relevant functions	Role in the project	Power / influence	Perception of process / impacts
	* Carries out activities on ecological and radiation safety, environment protection and sanitary protection of the country; * Develops proposals for improving the order of social support, particularly targeted social assistance and payment of benefits and compensation to the poor households	water borne diseases, coordinating/ cooperating on EMP implementation and compliance; Regulating and implementing the targeted social assistance for vulnerable HHs.		and compliance).
Ministry of Labor, migration and employment of the Republic of Tajikistan (MLME)	* Develops draft normative acts and laws in the field of labor, migration, employment, livelihood level of the population, basic vocational education as well as plan of action and forecast indicators of the Ministry's activity and submits them to the Government of the RT; * In collaboration with other relevant line ministries and agencies, develops proposals on priority directions of the state policy in the area of labor and population's livelihood level; * Studies, analyzes and evaluates the living conditions of the population; * Develops measures to stabilize and increase the level of population's livelihood based on forming of the income policy; * In conjunction with relevant ministries and agencies prepares proposals on minimum salaries, allowances and stipends; * Submits to the Government of RT proposals on improvement of the system of allowances and compensations, as well as on protecting population's income from inflation; * In cooperation with other relevant ministries and agencies, prepares proposals to improve the system of social partnership, carries out methodical guidance of the work on concluding regional agreements, sectorial (inter-sectorial), collective agreements, facilitates settlements of collective labor disputes, on issues pertinent to the Ministry's competence; * Participates in preparing the draft General Agreement between the Government of the RT and	* Migration Service under the MLME is in charge for issuing work permits for foreign workers, as well as for regular inspection of such permissions; * It also issues licenses for companies engaged in recruitment/ employment of foreign workers in Tajikistan	High power / low influence	High interest in the project and its outcomes, particularly in terms of employment/additional work places, compliance with the labor standards

Stakeholder / sub-group	Relevant functions	Role in the project	Power / influence	Perception of process / impacts
	Employers' Union of the RT as well as representatives of the employees, submits proposals on action plan for implementation of this Agreement; * Develops proposals on improvement of the workers' salary payment system in the frames of the tariff agreements and collective agreements; * Carries out tariff setting for works, professions and positions, develops normative basis for regulating salaries; * Endorses labor norms (standards),single tariff and qualification reference for works and professions, qualification reference book for positions, instructions, clarifications, recommendations on set up, regulation and payment of salary; * Develops and submits to the Government of the RT a list of productions, works and professions with hazardous working conditions, entitled for additional leave, reduced workday, free medical and preventive food; * Carries management of occupational safety and coordinates the work of ministries and agencies in this regard, develops inter-sectorial rules, organizational and methodical documents on occupational safety ; * Develops the list of hazardous professions where women and child labor is restricted and submits it for review to the Government of the RT, develops state statistics forms for reporting workplace accidents and incidents and professional diseases, the procedure for investigating accidents/incidents and professional diseases, norms of issuing work and foot-wear and other personal protection equipment (PPE); * Endorses the rules and norms on occupational safety, organizational, methodical and general technical requirements to implementation of occupational safety; * Carries out the work related to analyzing, implementing, evaluating professional/vocational education, including adult education.			
Ministry of Economic Development	* Participates in developing of the state policy in all the socio-economic fields of the country; * Develops short, medium and long term strategies, indicative plans and forecasts of socio-economic	Participates in negotiating loan agreements, regulating	Low power and influence	Interest in the Project high in view of

Stakeholder / sub-group	Relevant functions	Role in the project	Power / influence	Perception of process / impacts
and Trade (MEDT)	development and in conjunction with those, state programs on internal and external investments; * Coordinates sectorial and regional development programs; * Coordinates and controls (executive state bodies' and economic entities') implementation of commitments arising from international legal acts, acknowledged by the Republic of Tajikistan and international agreements; * Drafts proposal on concluding intergovernmental and international acts of the RT in the field of international economic relations, trade and economic and scientific and technical cooperation * Regulates prices (tariffs) subjects of natural monopolies, economic entities, having monopolistic market position on certain goods in the country.	tariffs etc.		increased income and improved energy generation potential of the country
Ministry of Agriculture (MoA)	Develops and implements agricultural sector policy, facilitates international economic relations for enterprises and organizations, facilitates development of agri-industry in the country, facilitates improvement of technique, technology and processing of agricultural crops	Seen as none at this stage, may evolve depending on the Project progress	Low power and influence	Interest low, despite the impact of flooding caused by water discharge on farming areas, affecting crop production etc. May represent farmers in this regard.
Committee on Emergency Situations (CES)	* Central executive government body in charge for implementing state policy, legal and regulatory framework, providing state services in the area of disaster management and civil defense; * Implements unified state policy in the field of preparedness and protection of the population, economic objects and country's territory from the emergency consequences; * Coordinates an array of state legal and defense and other activities aimed at protecting population	Seen as critical in coordinating the water discharge schedules and raising awareness/ preparedness when relevant among the	Low power and influence	Interest in the Project impact (emergency management plan) is high, which became

Stakeholder / sub-group	Relevant functions	Role in the project	Power / influence	Perception of process / impacts
	and economic objects and the country's territory from the emergency consequences both natural and man-maid	downstream communities; Critical for coordinating the Emergency Management Plan with Nurek HPP (during the project implementation/ operation phases)		evident based on the public consultations. Close cooperation is important, probably through establishing a coordinating body for the Project (CES), ALRI, MoA, MEWR, BT/Nurek HPP, CEP
Agency on Land Reclamation and Irrigation (ALRI)	* Central executive government body in the field of land reclamation and irrigation 6 ; * Develops unified state policy, legal and regulatory environment in the field of land reclamation and irrigated lands, use and maintenance of water management infrastructure, supply and protection of water resources; * Manages irrigation and drainage infrastructure, including repair works etc.	Its irrigation and drainage infrastructure receive water after the water discharge in Nurek HPP. The Consultation in Dusti district suggest that downstream areas suffer from flooding mainly due to lack of coordination on the schedule and/or inadequate maintenance	Low power and influence	Interest should be high, because their infrastructure will be taking water at discharge, and will be affected by the flooding too. Need coordinating mechanism, as descried above

Stakeholder / sub-group	Relevant functions	Role in the project	Power / influence	Perception of process / impacts
		of irrigation and drainage infrastructure/ uncleaned canals fail taking water.		together with CES, MEWR, BT/Nurek HPP, MoA, CEP etc.
Bilateral and multilateral agencies/ donors (ADB, BRD, IDB etc.)	ADB is one of the largest donor agencies, funding infrastructure rehabilitation, including energy sector in Tajikistan. It financed rehabilitation works on Nurek HPP (switchyard), Golovnaya HPP etc. EBRD's portfolio accounts for 42% in energy sector in the country, including rehabilitation of Qayroqqum HHP and energy loss reduction, but mainly in the Northern Tajikistan.	Interest in the project and its outcome, including its contribution to the energy loss reduction; interest is also from a perspective of the joint country partnership work.	High power and influence	Interest high
TajCnet	Network of NGOs active in the field of climate change, environment protection.	Interested in public monitoring of the project and its impact on social and environmental issues	Low power and influence	Interest high, particularly in the project outcome, including impact on climate change, downstream effect on natural reserves etc.
Institute of Water Problems, Hydropower	The Institute was established in 2002 based on the Department of Water Problems and Ecology of the Academy of Sciences of the Republic of Tajikistan and its mandate includes research in the field of water resource management, including transboundary water bodies, hydropower and ecology in existing six laboratories: (i) water resources and hydro- physical processes; (ii) Environment and	Interested in project and its outcomes, particularly in relation to the rehabilitation of the	Low power	High interest and potential for cooperation during project

Stakeholder / sub-group	Relevant functions	Role in the project	Power / influence	Perception of process / impacts
Engineering and Ecology under the Academy of Science of the RT	Sustainable Development; (iii) power engineering, and resource-saving; (iv) climatology and glaciology; (v) water quality, hydro and biogeochemistry; (vi) modeling and information management.	dam and its safety provisions, environmental impacts on the downstream communities. Carried out research of the number of transboundary water bodies, and currently studies Amudarya/Pyanj river basin		implementation, including by involving institute in design and planning and/or implementation.
Private Sector	Private sector functions range from providing consulting services for various projects, including infrastructure/energy, design, implementation support to supply of goods and services.	Participating in the project in association with the International consulting companies and/or outsourced the public consultations and other activities, bidding for supply of goods and services, local business would benefit from increased number of foreign and local personnel during the project implementation, intensified traffic etc.	Low power	Have high interest in the project and in general positive perception of the project

7.3.1.2. REGIONAL LEVEL

Table 41 details all identified stakeholders at regional level.

Table 41 – Stakeholders at regional level

Stakeholder / sub-group	Relevant functions	Link with the project	Power / influence	Perception of process / impacts
Tigrovaya Balka Natural Reserve	Unique wildlife reserve protecting rare species of tugay, or riparian forest, ecosystems (flora and wild animals).	The reserve suffers from lack of water in Vakhsh river, which affects the water levels in the numerous lakes of the reserve, which are habitat for unique and protected flora and fauna. The consultation in Dusti district suggests that the reserve also is adversely affected by the (seasonal) water discharge from Nurek and Baipaza HPP endangering the unique species	Low power and influence	Interest high, need to be included as part of the coordinating mechanism to regulate the water discharge schedule and/or ensure awareness raising/proper notification on the schedule, develop mitigation measures for minimizing flooding risk
Community based natural resource management organizations, WUAs, farmers	Farmers and users of water resources located downstream Vakhsh river, who are potentially impacted by the flooding risk and water discharge/modification of water flows	Have high interest in the project impact in view of its water discharge impact causing floods. This impacts their livelihoods, which relies on agriculture mainly	Low power and influence	High interest in project and its impacts on the downstream water resource/impact management patterns. Need to be closely consulted and informed throughout the project implementation.

7.3.1.3. LOCAL LEVEL

Table 42 details all identified stakeholders at regional level.

Table 42 – Stakeholders at local level

Stakeholder / sub-group	Relevant functions	Role in the project	Power / influence	Perception of process / impacts
Communities of Nurek (the City and Dukoni jamoat and Puli Sangin jamoat	Local residents, including women, children, elderly, disabled, living adjacent to the only road connecting Nurek to the capital city and which will be using for transporting goods and materials during the project implementation	While the communities are also dependent on the electricity generated by the Nurek HPP, the HPP creates employment for the population; communities have range of concerns related to the project impacts, despite having a very positive attitude and perception about the project.	Low power and influence	Interest is high, for various reason, including improved power generation, positive socio-economic impacts of the Project. However, need to be intensively consulted throughout the Project lifecycle and beyond. Topic for next consultations should include topics such as traffic management plan, health and safety measures, including the data on correlation of cardiovascular diseases trend and a widespread myth on adverse impact of magnetic field generated by the Nurek HPP, job announcements/employment procedures, GRM etc.
All relevant local authorities	This includes local/city level SES, CES, Environmentalists, traffic police and City Municipality	Implementation level activities will be mainly dealt with the local level government stakeholders. It is important to involve them at the early stages of the Project to ensure efficiency and avoid possible delays	High power and influence	Interest is high in the Project and its impacts both positive and negative

7.3.1.4. CLASSIFICATION OF THE STAKEHOLDERS

Depending on their power and interest in the project, stakeholders can be classified into a matrix (see Figure 48). This classification makes it possible to know what general policy to adopt with each stakeholder or group of stakeholders.

Figure 48 – Power / Interest matrix of stakeholders

Power	Low Interest	High Interest
High	**KEEP SATISFIED** -	**MANAGE CLOSELY** MEWR Barqi Tojik Nurek HPP CEP MHSPP/SES MLME All relevant local authorities Bilateral and multilateral agencies/ donors (ADB, EBRD, IDB etc.)
Low	**MONITOR (MINIMUM EFFORT)** ALRI MoA	**KEEP INFORMED** Communities of Nurek (the City and Dukoni and Puli Sangin jamoats) Community based NRM organizations, WUAs, and farmers TajCnet Tigrovaya Balka Natural Reserve CES MEDT SISPMC Academy of science (Institute of water)

7.3.2. Participation

The participants were from different ethnic groups, including Tajik, Uzbek, Russians and Turkmens. Hence, the languages used for the consultations were Russian and Tajik.

Age composition of the participants was also different, including elderly and youth. Representatives of the youth committees participating at the events reported they will be circulating the information among their peers during various events and meetings.

Participants at all the regional and local level included representatives of the diverse stakeholders, such as heads of the *mahalla* (communities), heads of women committees (informal and formal), healthcare workers, including Sanitary and Epidemiological Services, environmentalists, heads of educational facilities, representatives of the Housing and Utilities companies, private entrepreneurs, unemployed, disabled persons, road and transport department representatives, farmers, NGOs, employment departments, financial department, Nurek HPP personnel, and eventually representatives of local authorities at district and oblast (region) level, as well as *jamoat*.

The meetings were also attended by elderly representatives from both Nurek and Dukoni *jamoat*.

Consultations took course in the environment enabling for free unintimidating exchange of ideas, concerns and recommendations, so everyone had a chance to speak. This was particularly noticed when women presented their concerns and shared their recommendations on the ESMP.

The national level consultation participants represented NGOs, academia, including Academy of science and universities, donor agencies, Institute of Water Problems, private consulting companies, Association of hunters, Committee on Environment Protection and the International Committee on Water Coordination.

7.3.3. Issues raised

The main issues raised during the consultations are summarized in the Table 43. The relevance of their treatment in the framework of the project is also indicated, with the corresponding explanations where appropriate.

Table 43 – Main issues raised by consultations

Key issue raised	Relevance for the project	Proposed treatment of the issue
Cardiovascular diseases caused by the **magnetic field** created by the Nurek HPP (*mentioned several times*)	EMF is an issue for HPP workers and project team, but there is no scientific proof of a link between the two facts. Besides, the Project will not modify the current working conditions on this point.	This issue should be specifically highlighted in the second round of consultations. Monitoring may be established to reassure the public of compliance with

Key issue raised	Relevance for the project	Proposed treatment of the issue
	(see section 0 and 5.3.9)	exposure values. An awareness campaign could be launched, but it's outside the framework of the project.
Use of **alternative road** to avoid trespass through the city while transporting goods and equipment during the construction stage. There is a bridge available and could be used for this purpose. However, the bridge needs rehabilitation.	Yes This option requires a specific techno-economic study (see section 4.1.2). This study could be inserted into the Contractor's scope.	Further reflection on this issue should be one of the important points of the second round of consultations.
Nurek HPP causes disasters at **discharging water** from the reservoirs. Barki Tojik and Nurek HPP should take into consideration that such discharges currently causes degradation and flooding of the canals banks in Tigrovaya Balka in particular, and in the downstream districts in general	The project will be supporting introduction of improved flood forecasting and management system. This will ensure that the Nurek HPP dam is capable of handling 1 in 100,000 year floods vs. 1 in 10,000 year floods currently. Overall, the project has no impact on the downstream discharge at a daily time-scale (see section 5.3.1). This is rather an issue of coordination between the Agency on Land Reclamation and Irrigation and Committee on Emergency Situations together with BT, where each institution would first communicates the plans, including the water discharge schedule, and works out the mitigation measures and awareness raising/notification for the downstream communities.	Explanation in the second round of consultations. It would be beneficial for the project that these stakeholders investigate this subject in order to come up with feasible and effective solution and provide an informed answer to the concerned populations.
Traffic management plan should limit transporting heavy loads/carrier vehicles to avoid transportation during peak hours – 7:00-8:00 in the morning and 17:00 – 18:00 in the evening	Yes The traffic management plan will be prepared by the Contractor, and these constraints will be communicated to him.	Explanation in the second round of consultations, whether or not these constraints have been taken into account (some work may require special schedules and specific measures). This could be addressed simultaneously with the

Key issue raised	Relevance for the project	Proposed treatment of the issue
		alternative route issue (see above).
Reinstating of any damaged assets/infrastructure	Yes This condition will be included in the requirements imposed on the Contractor.	Explanation in the second round of consultations. This could be addressed simultaneously with the alternative route and traffic management plan issues (see above).
Asbestos risk/hazard for population, including in a domestic framework	Asbestos is identified as a high risk for the workers in the framework of the refurbishment project (see section 0) and will be treated accordingly. On the other hand, domestic risk is not within the scope of the project.	Explanation in the second round of consultations.
Potential **employment opportunities**	Yes (see section 0)	Further explanation in the second round of consultations about staff requirements (number of people, types of work) and recruitment procedures and criteria.
Before and during project implementation local population in Nurek and adjacent jamoats should receive **timely and updated information** on any critical schedules of work and activities Will **similar consultations be conducted again**, when there will be updated information or the project starts?	Yes This is one of the major points of the SCIDP (see section **Error! Reference source not ound.**).	Explanation in the second round of consultations.
Who will do the civil works?	Yes But the Contractor is not known yet.	Details about the Contractor will be included in the information delivered during the next round of consultations.
Monitoring of the epidemiological situation	The global monitoring of the epidemiological situation in	Explanation in the second

Key issue raised	Relevance for the project	Proposed treatment of the issue
and **health conditions of population** during the project implementation	Nurek city and vicinity is not within the purview of the project. But a monitoring of the physicochemical parameters will be ensured during the project in order to respect the exposure values (see section 9.5.3)	round of consultations.
Siltation of Nurek HPP . Is it foreseen to clean the reservoir, for instance?	No The issue of siltation of the reservoir is not covered by the Project; however, the rehabilitation of the HPP will at least not contribute to siltation.	Explanation in the second round of consultations.
During Project implementation attention should be paid at gender issues, such as providing employment to women, access to information etc.	*See specific issues above*	-

In response to the issues raised, the ESIA was amended to include SEP. The SEP will be implemented by BT and will ensure that key stakeholders are regularly consulted during project implementation.

7.4. Next steps

The next stage will consist of a second round of consultations (a 'feedback' round) where:

- The status of the project and of the associated administrative procedures, in particular the ESIA, will be explained;
- The final ESIA will be made available to stakeholders;
- Unresolved issues or unanswered questions raised during the first round of consultations will be addressed during next round of information sharing. Definitive answers or elements of reflection on the question will be provided This next round of information sharing will take place in Spring 2017.

Then, during project implementation additional consultations will be conducted, at minimum, on an annual basis. As needed, exceptional meetings in case of a particular event or on a specific subject will be organized.

SEP provides a framework for subsequent consultations and is detailed in Appendix 3.Throughout the implementation process, the SEP (see Appendix 3) will be updated according to the evolution of the project, the measures taken, the intervention of new stakeholders, any potential new issues that may arise, etc. These are the operational documents of the project.

8. ANALYSIS OF ALTERNATIVES

The project alternatives to be studied consist of different variants related to schedule and the “no project” option.

8.1. Refurbishment alternatives

Nurek HPP is composed of 9 units which are all currently limited in terms of power capacity due to vibration and temperature issues.
Unit 8 has not been in operation for the last 4 years due to refurbishment of runner and Main inlet valve (MIV) as well as transformer issues s. The efficiency issues of the other eight units cumulatively represent another unit out of operation.

Currently, the refurbishment alternatives are the following:

- Recovering of the full installed capacity only, or increasing the power capacity (by 4%, 8% or 12%);
- Refurbishment schedule with one unit after the other or 2 units simultaneously.

- **Refurbishment with or without power capacity increase**

There is no negative impact for either alternative.

On the other hand, there is a clear positive impact with a capacity increase: the higher the increase of the capacity, the higher the potentially available energy will be, especially for peak production.

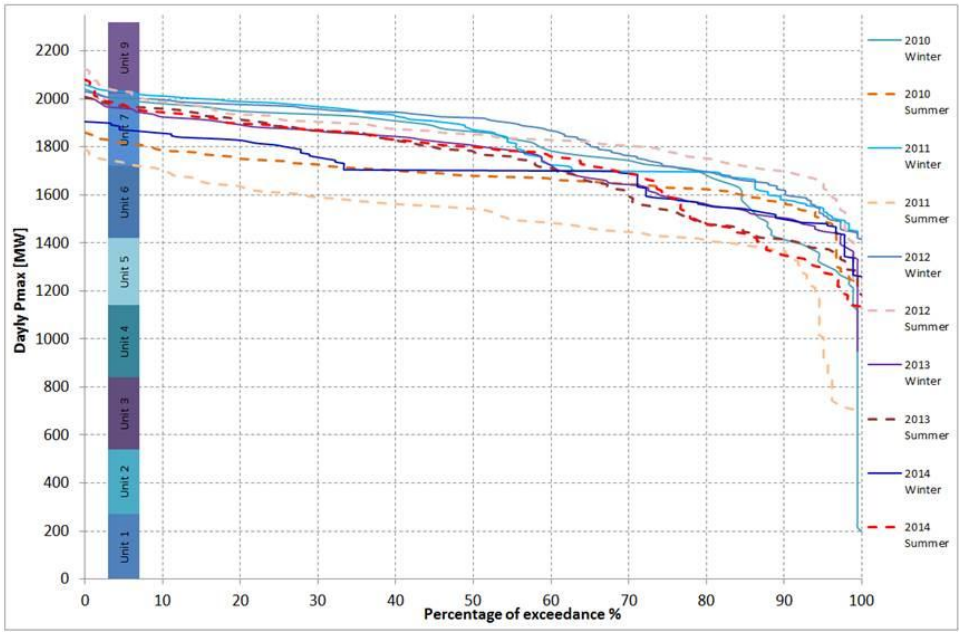
- **Rehabilitation of 1 or 2 units simultaneously**

Although this alternative is at the moment rejected by the Tajik Authorities, the case where two units may be immobilized simultaneously for rehabilitation must be considered.

The obvious positive impact of refurbishing 2 units simultaneously is to speed up the recovery of the full capacity (or more) of the HPP.

On the other hand, the available power capacity of the plant will be reduced in the first years of the project. In this case, there is a theoretical negative impact on the maximum generation. This is shown in the following graph representing the winter/summer daily power duration curves in the last years of operation put in perspective of the current available capacity of the power plant (2,320 MW).

Figure 49 – Winter/Summer daily power duration curves by year (2010-2014)



The immobilization of a second unit would make peak daily productions above an average of 2,000 MW (observed about 5% of time in recent years) impossible. It would also mean that to achieve the same levels of production, all remaining 7 units would stay in operation 60 to 70% of the time (at least from a daily time-scale perspective).

To quantify this possible negative impact will require checking:

- With the Nurek HPP staff: if this situation is acceptable from the operating and maintenance point of view;
- With the network operator: if this unavailability may be compensated for by other sources of energy production or *via* network connections.

8.2. No refurbishment alternative

From an environmental point of view, the no refurbishment alternative is not attractive considering the low impact of the refurbishment project on the physical and biological components.

From a socio-economic point of view, this alternative is less advantageous, because it does not (i) improve/restore the total installed capacity, (ii) improve the production of energy for Tajikistan but also others country of the region, (iii) ameliorate the prevention of the dam safety risk (for operators and downstream communities).

Finally, from a hydroelectric point of view, this alternative would lead to the continuation of the current trend, that is to say the gradual reduction of energy production by the degradation of electromechanical equipment. This will also lead to an increase of the flood risk with the reduction of the flood management ability of the HPP, and thus a reduction of the dam safety security and an increase of the risk to downstream populations.

9. ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

9.1. Objectives

The Environmental and Social Management Plan (ESMP) will help Nurek HPP refurbishment project to prevent and manage the adverse environmental impacts or risks associated with the project and introduce standards of good environmental practice.

Based on the identification and assessment of impacts, the ESMP through mitigation measures aims to avoid or minimize the impacts associated with implementation of various planned works.

- Avoidance. If possible, measures will have to be sought, which can avoid the impacts altogether.
- Minimization. Measures to reduce impacts to an acceptable level.

Measures are presented in an operational manner. For each measure, objectives, activities and modalities for their implementation as well as responsibilities are given.

9.2. Methodology

Relevant National laws on environmental protection, occupational health and safety are listed in chapter 2.1.

The IFC (part of the World Bank Group) EHS Guidelines have been used as international standards. Table 44 lists the topics which are covered by these guidelines.

The methodology for the establishment of the ESMP summarizes the impacts by affected environmental component, project phase and task.

The measures are organized as specific ESMP programs / plans.

The ESMP applies to the entire area facing the impacts of the project. The ESMP includes the following programs:

- ESMP01: Environmental Health and Safety Plan;
- ESMP02: Pedestrian and traffic safety plan;
- ESMP03: Emergency Preparedness and Response Plan;
- ESMP04: Work permit

Table 44 - IFC EHS Guidelines which have been applied for the ESMP

1. Environmental
1.1 Air Emissions and Ambient Air Quality
1.2 Energy Conservation
1.3 Wastewater and Ambient Water Quality
1.4 Water Conservation
1.5 Hazardous Materials Management
1.6 Waste Management
1.7 Noise
1.8 Contaminated Land
2. Occupational Health and Safety
2.1 General Facility Design and Operation
2.2 Communication and Training
2.3 Physical Hazards
2.4 Chemical Hazards
2.5 Biological Hazards
2.6 Radiological Hazards
2.7 Personal Protective Equipment (PPE)
2.8 Special Hazard Environments
2.9 Monitoring
3. Community Health and Safety
3.1 Water Quality and Availability
3.2 Structural Safety of Project Infrastructure
3.3 Life and Fire Safety (L&FS)
3.4 Traffic Safety
3.5 Transport of Hazardous Materials
3.6 Disease Prevention
3.7 Emergency Preparedness and Response
4. Construction and Decommissioning
4.1 Environment
4.2 Occupational Health & Safety
4.3 Community Health & Safety

The ESMP also includes monitoring programs:

- P01: EHS Management and Monitoring Plan;
- P02: Hydrological Monitoring.

Details about supervision and monitoring of the ESMP execution are also given in this chapter (responsibilities, tasks, costs, etc.).

The Contractor will be responsible for construction, management, maintenance and restoration of all the sites used in refurbishment of the project. To ensure that responsibility, it is required that the Contractor meets the organizational and technical requirements defined in this ESMP and the relevant section of the bidding documents.

To comply with the requirements of the Project Owner (BT) and the Lenders (financing institutions), the Contractor must propose to the Project Owner and Lenders a Health and Safety Environment Plan for its construction activities. It will be detailed all the organizational and technical measures to be implemented throughout the construction. This plan must be prepared upon receipt of the order of service. The document will be presented in draft form to the Project Owner before commencement of works. The Health and Safety Environment Plan will then be finalized by the Contractor after taking into account the remarks of the Project Owner and Lenders before the commencement of the works.

All technical measures defined in the Health and Safety Environment Plan are best environmental and social practices closely related to construction activities and therefore, in terms of schedule and cost, are inseparable from construction activities. As such, it will be considered that all the costs required to implement the Contractor's Health and Safety Environment Plan are included in the costs of construction and equipment.

In any case, the Project Owner has the following overall main responsibilities concerning environmental management (in the wider sense of the term):

- To make sure that the required measures are properly implemented, whether by him directly or by a third party;
- To formulate clear conditions (in the tender documents) for all obligations of the contractor(s); it must be very clear that such conditions, e.g. Concerning EH&S measures, also apply to subcontractors, and that the contractor has a responsibility for their performance;
- To monitor implementation of these measures (by its own work force and by subcontractors) and to take adequate steps in case of non-compliance.

Contactor responsibilities shall include:

- The timely preparation and implementation of environmental and social measures as stipulated in contractual documents;
- To ensure appropriate quality assurance, control and enforcement measures (internal monitoring) related to environmental and social aspects;
- To ensure that local grievance and complaints mechanisms are in place to handle disputes in a timely manner.

National and local government agencies' responsibilities will include:

- To ensure compliance with legal requirements under their jurisdiction;
- To support and facilitate the implementation of key elements of the ESMP.

9.3. Preparation and approval of the site-specific ESMPs

The ESMPs will be prepared by the Contractor upon receipt of the order of service. The document in draft form will be presented to the Project Owner no later than 2 months before the engagement of works. The ESMP will be finalized by the contractor after taking into account the remarks of the Project Owner and the Lenders. These remarks will be transmitted to the Project owner within 15 days of receipt of the draft document. The final version will be presented to the client 1 month before the engagement of works at the latest.

9.4. Mitigation measures

Mitigations measures correspond to avoidance and minimization measures.

9.4.1. ESMP01: Environmental Health and Safety Plan

For rehabilitation works, it is important to underline the importance of establishing a good working relationship between the operators of Nurek HPP and the international contractor because these two parties operate on the basis of different standards and practices. This aspect highlights the importance of an **Environmental Health and Safety Plan (EHS Plan), coordination meetings and the establishment of common procedures** for working zones.

The objectives of the EHS Plan which contains the social and environmental specifications are (i) to reduce or avoid the risk of pollution dealing with subjects as wastewater and water quality, hazardous materials, waste, noise and soil contamination; (ii) to guarantee for workers at the construction site, in view of the risks previously identified, that reduction and suppression measures are taken and applied to ensure hygiene and safety conditions and (iii) to ensure community health and safety.

The EHS Plan shall be prepared, implemented and supported by the Contractor in charge of the works.

Based on the World Bank Group EHS guidelines[24] this chapter gives guidelines and proposes EHS measures to be included in the bid documents.

9.4.1.1. AIR EMISSIONS AND AMBIENT AIR QUALITY

The project should prevent or minimize impacts by ensuring that:

- Emissions do not result in pollutant concentrations that reach or exceed relevant ambient quality guidelines and standards by applying national regulatory standards, or in their absence, the current World Health Organization (WHO) Air Quality Guidelines or other internationally recognized standards;
- Workers are not exposed to asbestos dust during works.

In this project, the most common pollutant that will be encountered in fugitive emissions is dust or particulate matter (PM) during transport but in a more important manner in confined environments. The Contractor shall make arrangements to avoid or reduce air pollutant emissions, particularly dust and other particulates.

General specifications for air quality include:

- Keep a distance between vehicles (access road), temporary refurbishment facilities and residential areas;
- Avoidance of crossing residential areas;
- Covering of trucks carrying materials with tarps;
- Use of dust-control devices on vehicles and watering of the tracks on the most exposed sites;
- Limiting vehicle speed;

[24] Environmental, Health, and Safety (EHS) Guidelines. GENERAL EHS GUIDELINES: INTRODUCTION. IFC, 2007

Emissions from on-road and off-road vehicles should comply with national or regional programs. In the absence of these, the following approach should be considered:

- Fleet owners / operators should implement the manufacturer's recommended engine maintenance programs;
- Drivers should be instructed on the benefits of driving practices that reduce both the risk of accidents and fuel consumption.

In addition to the general specifications for maintaining air quality, a **specific procedure shall be drafted by the Contractor** in order to deal with the asbestos removal if any, monitor the air concentration of asbestos dust, and manage any risk for workers (ingestion of asbestos fibers). All measures proposed and implemented by the specialist shall be taken to ensure proper asbestos waste management, from the packing to the monitoring of asbestos waste. Special precautions must be taken and specific procedures should be followed during the dismantling process:

- Workplace preparation:
  - Marking areas, indicated by panels of asbestos risk and entry restrictions;
  - Provision of decontamination units;
  - Provision of confinement and air handling units (extractors with filters).
- Removal:
  - Execution of the works in accordance with the technical and regulatory requirements;
  - Application of removal procedures proposed by the specialist appointed by the Contractor.
- Control: Various controls should be performed throughout the site, both in and outside the relevant areas, to verify the actual rate of dust accumulation and if necessary implement the appropriate corrective measures.

9.4.1.2. INDUSTRIAL WASTEWATER AND AMBIENT WATER QUALITY

Industrial wastewater generated by refurbishment operations include wastewater from operations, runoff from process and materials staging areas. The pollutants in an industrial wastewater may mainly include heavy metals, oils, hydrocarbons, Polycyclic Aromatic Hydrocarbons (PAHs) and volatile materials.

The Contractor shall (i) implement measures to prevent any inadvertent discharge of polluted effluent into surface waters downstream of Nurek HPP, and (ii) set up a procedure for collection, storage and treatment. Transfer of pollutants between air, soil or the sub-surface, should be minimized through process and engineering controls.

General specifications about industrial wastewater include:

- Pollutants from the refurbishment process should not be discharged in the Vakhsh River or should be separated from the return flow to the Vakhsh River;
- Contamination of surfaces in the powerhouse during refurbishment should be prevented or reduced;
- The pollutant concentrations and flows discharged into the natural environment should be monitored;

- If sewage from the industrial facility is to be discharged to surface water, treatment should be carried out to meet national or local standards for sanitary wastewater discharges.

In addition to general specifications for maintaining water quality, **specific principles and procedures should be drafted by the Contractor** in order to deal with situations of inadvertent liquid pollutant discharge or leakage:

- Oil water separators, grease traps and other hazardous material treatment devices should be installed and maintained as appropriate at the refurbishment workplace, and truck parking areas;
- An emergency plan should be prepared and implemented in case of spills;
- Segregation and pre-treatment of effluents containing oil and grease (e.g. use of a grease trap) prior to discharge into sewer systems;

9.4.1.3. NON-HAZARDOUS WASTE MANAGEMENT PLAN

The following guidance applies to the management of non-hazardous waste. Additional guidance specifically applicable to hazardous wastes is presented below. Waste management should be addressed through a Waste management system that addresses issues linked to waste minimization, generation, transport, disposal, and monitoring.

General specifications for industrial wastewater management include:

- **Planning**. The project Contractor should (i) identify waste sources; (ii) characterize the waste according to composition, source, types of waste produced, generation rates, or according to local regulatory requirements. (iii) establish waste management priorities at the outset of activities based on an understanding of potential Environmental, Health, and Safety risks and impacts and considering waste generation and their consequences. (iv) establish a waste management hierarchy that considers prevention, reduction, reuse, recovery, recycling, removal and finally disposal of waste;
- **Waste prevention.** Processes should be designed and operated to prevent, or minimize the quantities of waste generated and hazards associated with the waste generated;
- **Recycling.** In addition to the implementation of waste prevention strategies, the total amount of waste may be significantly reduced through the implementation of recycling plans;
- **Treatment and disposal**. Waste materials should be treated and disposed of and all measures should be taken to avoid potential impacts on human health and the environment. Selected management approaches should be well suited to the type of waste and consistent with local requirements and regulations;
- **Waste storage.** Waste should be stored so as to prevent or control accidental releases to air, soil, and water resources at the site. Recyclable and unrecyclable materials should also be stored separately;
- **Transportation.** Off-site transportation of waste should be conducted so as to prevent or minimize spills, releases, and exposure of employees and the public. All waste containers designated for off-site shipment should be secured and labeled with the contents and associated hazards, be properly loaded on the transport vehicles before leaving the site;

- **Monitoring.** Monitoring activities associated with the management of hazardous and non-hazardous waste should include:
  - Regular visual inspection of all waste storage collection and storage areas;
  - Regular audits of waste segregation and collection practices;
  - Tracking of waste generation trends by type and amount of waste generated;
  - Keeping manifests or other records that document the amount of waste generated and its destination;
  - Regular audits of third party treatment and disposal services.

Recycling solutions should not be overlooked. This should be done by agreement between the Contractor and the Project owner. Certain principles should be followed in the Contactor's proposal:

- Distinction of recyclable and unrecyclable materials shall be proposed and detailed by the Contractor, any profits (reuse, sale, etc.) shall accrue to the Project owner;
- Recycling solutions shall be studied depending on waste type (electrical devices, hydro-mechanical equipment, iron waste, etc.). Equipment and instrumentation that are still functional will require a detailed analysis (i) for a current or future use by the Project owner (on this site or other HPP) and (ii) resale possibilities

9.4.1.4. HAZARDOUS WASTE MANAGEMENT PLAN

A Hazardous Waste Management Plan shall be prepared by the Contractor to comply with the relevant IFC Environmental, Health and Safety Guidelines.

The Contractor should propose measures or plans to (i) manage hazardous waste and (ii) manage major hazards. The overall objective of hazardous waste management is to avoid or, when avoidance is not feasible, minimize uncontrolled releases of this hazardous waste during its handling and storage.

Regarding the management of hazardous waste and in addition to the management of non-hazardous waste (see previously), the Contractor shall:

- Conduct a hazard assessment using internationally-accepted methodologies, through a specialized professional if necessary;
- Prepare and implement a Hazardous Waste Management Plan for prevention of harm to Health, Safety, and the Environment in which:
  - The removal of the hazardous materials and confinement procedures are to be implemented by a specialized professional;
  - The hazardous wastes transport and storage follow national regulations or internationally accepted procedures;
  - **Waste storage**. The hazardous waste storage is separated from non-hazardous waste. Hazardous waste should be stored so as to prevent or control accidental releases to air, soil, and water resources;
  - **Transport**. Contractor shall propose a Hazardous Materials Transportation Plan (This plan is developed in the Chapter 9.4.1.12 "Transport of Hazardous Materials measures");
  - **Treatment and disposal**. Hazardous waste treatment and disposal is managed by a specialized professional, particularly for asbestos. In the absence of a specialized professional, the Contractor should consider:
    - Installing on-site waste treatment or recycling processes;

    - As a final option, constructing facilities that will provide for the environmentally sound long-term storage of waste on-site or at an alternative appropriate location until external commercial options become available;
- **Control**. In addition to the requirements for non-hazardous wastes:
    - Regular monitoring of groundwater quality is to be implemented on storage site and/or pretreatment and disposal;
    - Monitoring records for collected, stored, or shipped hazardous waste include more detailed information (name and identification number of the material; physical state; quantity; waste shipment tracking document; location of each piece of hazardous waste; method and date of storing, repacking, treating, or disposing);
- **Hazard communication and training programs** are implemented to prepare workers to recognize and respond to workplace chemical hazards. Programs should include aspects of hazard identification, safe operating and materials handling procedures, safe work practices, basic emergency procedures, and special hazards unique to their jobs.

Regarding the management of hazards, the Contractor shall prepare a spill control, prevention, and countermeasure plan as a specific component of their **Emergency Preparedness and Response Plan** (see Chapter 9.4.3).

9.4.1.5. ROTATING AND MOVING EQUIPMENT

The reduction of the risk of injuries due to rotating and moving equipment will be possible with preventive measures:

- Designing machines to eliminate trap hazards and ensuring that extremities are kept out of harm's way under normal operating conditions. Examples of proper design considerations include (i) the availability of emergency stops dedicated to the machine and placed in strategic locations. (ii) Where a machine or equipment has an exposed moving part that may endanger the safety of any worker and cannot be modified, the machine or equipment should be equipped with a guard or other protective device that prevents access to the moving part. Guards should be designed and installed in compliance with relevant machine safety standards;
- Designing and installing equipment, where feasible, to enable routine service, such as lubrication, without the removal of the protective devices or mechanisms.

9.4.1.6. NOISE

- **Confined work environment**

Noise limits for different working environments are provided in the following table according to the World Bank Group. No employee should be exposed to a noise level greater than 85 dB(A) for a duration of more than 8 hours per day without hearing protection.

Table 45 - Noise Limits for various working environments

Location /activity	Equivalent level LA eq ,8h	Maximum LA max ,fast
Heavy Industry (no demand for oral communication)	85 dB(A)	110 dB(A)
Light industry (decreasing demand for oral communication)	50-65 dB(A)	110 dB(A)

The use of hearing protection should be enforced actively when the equivalent sound level over 8 hours reaches 85 dB(A), the peak sound levels reach 140 dB(C), or the average maximum sound level reaches 110dB(A). The protective devices should be capable of reducing sound levels at the ear to a maximum of 85 dB(A).

Periodic medical hearing checks should be performed on workers exposed to high noise levels.

- **Regarding communities**

We consider that the hydro-electromechanical equipment of the dam installed during refurbishment is not nosier that the previously existing equipment. Nevertheless, traffic and temporary refurbishment facilities can generate noise that may affect local communities.

Methods for prevention and control of sources of noise emissions should be specifically adapted to this project with regards to the source of noise and the receptor (the Nurek city). Noise reduction options that should be considered include:

- Selecting equipment with lower sound levels;
- Limiting the hours of operation for refurbishing operations;
- Siting temporary refurbishment facilities away from community areas if possible;
- Reducing project traffic routing through community areas wherever possible;
- Developing a mechanism to record and respond to complaints.

According to the World Bank Group, noise impacts should not exceed the levels presented in Table 1.7.1, based on WHO recommendations, or result in a maximum increase in background levels of 3 dB at the nearest receptor location off-site.

Table 46 - Noise level guidelines[25]

Receptor	One hour L_{Aed} (dBA)	
	Daytime (07:00 - 22:00)	Night time (22:00 - 07:00)
Residential; institutional; educational	55	45
Industrial; commercial	70	70

Noise monitoring may be carried out, by a trained specialist, for the purposes of establishing the existing ambient noise levels in the area of the proposed or existing facility, or for verifying operational phase noise levels.

9.4.1.7. RISK OF ELECTROCUTION

General measures to reduce the electrical risk for workers include the following:

- Dismantling electrical devices in proper conditions;
- Marking all energized electrical devices and lines with warning signs;
- Locking out and tagging-out (warning sign placed on the lock) devices during refurbishment;
- Double insulating / grounding all electrical equipment used in environments that are, or may become, wet; using equipment with ground fault interrupter (GFI) protected circuits;
- Protecting power cables and extension cables against damage from traffic by shielding or suspending above traffic areas;
- Appropriate labeling of service rooms housing high voltage equipment ("electrical hazard"), control or prohibition of their entrance;
- Conducting detailed identification and marking of all electrical wiring prior to any dismantling work.

A specific measure will also help avoid electrical risk for workers and reduce operational risk. This measure is the use of a "work-permit" system detailed in the chapter 9.4.4 (ESMP04: Work Permits).

9.4.1.8. WELDING / HOT WORK

Measures to reduce welding/hot work risks for workers include the following:

- Provision of proper eye protection such as welder goggles and/or a full-face eye shield for all personnel involved in, or assisting in, welding operations;
- Use of welding barrier screens around the specific work station;
- Devices to extract and remove noxious fumes at the source may also be required;
- Special hot work and fire prevention precautions should be implemented if welding or hot cutting is undertaken outside established welding work stations;

[25] Guidelines values are for noise levels measured out of doors. Source: Guidelines for Community Noise, World Health Organization (WHO), 1999.

- Existing fire safety prevention measures and devices should be in compliance with the regulation and refurbishment task risks. Otherwise, a Life and Fire Safety Plan (L&FS Plan) should be proposed in the Emergency Preparedness and Response Plan (see Chapter 9.4.3), and implemented by the Contractor. This plan should include measures such as:
  - The identification of fire risks and ignition sources;
  - Means of egress;
  - Detection and alarm systems;
  - Confinement;
  - Fire suppression and control devices;
  - An operation and maintenance control program.

These measures can also be useful for reducing electrical hazards risks, waste fire and hazardous waste fire.

9.4.1.9. BODILY INJURIES

Many bodily injuries may affect workers during the project. These may affect eyes, hands, head, etc.

- Personal Protective Equipment (PPE) provides an extra level of personal protection to workers exposed to workplace hazards. PPE are considered to be a last resort when the other facility controls and plans have failed. That is why this chapter comes in last position of the recommendations/measures.

  The following table presents general examples of occupational hazards and types of PPE available for different purposes.

Table 47 - Summary of recommended PPE according to hazard of the project

Objective	Workplace Hazards	Suggested PPE
Eye and face protection	Flying particles, molten metal, liquid chemicals, gases or vapors, light radiation	Safety Glasses with side-shields, protective shades, etc.
Head protection	Falling objects, inadequate height clearance, overhead power cords	Plastic Helmets with top and side impact protection
Hearing protection	Noise	Hearing protectors (ear plugs or ear muffs)
Foot protection	Falling, moving or rolling objects, pointed objects	Safety shoes and boots
Hand protection	Hazardous materials, cuts or lacerations, vibrations, extreme temperatures	Gloves made of rubber or synthetic materials (Neoprene), leather, steel, insulating materials, etc.
Respiratory protection	Dust, fogs, fumes, mists, gases, smokes, vapors	Facemasks with appropriate filters for dust removal and air purification. Single or multi-gas personal monitors
Body/leg protection	Hazardous materials, cutting and laceration	Insulating clothing, body suits, aprons, etc., of appropriate materials

Recommended measures for the use of PPE in the workplace include:

- Active use of PPE if alternative technologies, work plans or procedures cannot eliminate, or sufficiently reduce, a hazard or exposure;
- Identification and provision of appropriate PPE that offers adequate protection to the worker, co-workers, and occasional visitors;
- Proper maintenance of PPE.

- PPE cannot only be the only measure to be implemented to prevent bodily injuries. Work plan or procedures have to be developed and applied to reduce risks.

For example, measures to reduce hazards to workers' eyes include the following:

- Use of machine guards or splash shields and/or face and eye protection devices, such as safety glasses and/or a full face shield;
- Specific Safe Operating Procedures (SOPs) may be required for use of grinding tools and/or when working around liquid chemicals;
- Frequent checks of these types of equipment prior to use to ensure mechanical integrity is also good practice;
- Machine and equipment guarding should conform to international standards;
- Moving areas where the discharge of solid fragments, liquid, or gaseous emissions can reasonably be predicted (e.g. discharge of sparks from a metal cutting station, pressure relief valve discharge) away from places expected to be occupied or transited by workers or visitors;
- Where machine or work fragments could present a hazard to transient workers or passers-by, extra area guarding or proximity restricting systems should be implemented, or Personal Protective Equipment (PPE) required for transients and visitors.

9.4.1.10. WORKING AT HEIGHTS

Fall prevention and protection measures should be implemented whenever a worker is exposed to the hazard of falling. Fall prevention may include:

- Installation of guardrails at the edge of any fall hazard area;
- Proper use of ladders and scaffolds by trained employees;
- Use of fall prevention devices, including safety belt and lanyard travel limiting devices to prevent access to fall hazard area, or fall protection devices (full body harnesses);
- Appropriate training in the use of the necessary PPE (full body harnesses);
- Setting up rescue and/or recovery plans, and making available the equipment to implement them.

9.4.1.11. TRAFFIC AND PEDESTRIAN SAFETY MEASURES

A specific chapter is dedicated to pedestrian and traffic safety measures (see ESMP02: Pedestrian and traffic safety plan).

9.4.1.12. TRANSPORT OF HAZARDOUS MATERIALS MEASURES

The risk associated with the hazardous waste transport can be prevented and thus reduced by implementing procedures that ensure compliance with local laws and international requirements applicable to the transport of hazardous materials. These procedures should be compiled in a Hazardous Materials Transportation Plan containing all of the elements presented below:

- Hazard assessment: the hazard assessment should identify the potential hazard involved in the transportation of each hazardous material;
- Management actions: compliance audit, incident investigation, employee participation, sub-contractors involvement, training, etc.;
- Preventive measures: the plan should include procedures to implement preventive measures specific to each hazardous material;
- Emergency preparedness and response: it is important to develop procedures and practices for the handling of hazardous materials that allow for quick and efficient responses to accidents that may result in injury or environmental damage.

9.4.2. ESMP02: Pedestrian and traffic safety plan

9.4.2.1. GENERAL OBJECTIVES

Pedestrian and traffic safety plan aims to prevent pedestrian and traffic risk during the refurbishment Nurek HPP in areas where workers and local communities can be injured by vehicles (cars and light trucks) used for the project (turbines are heavy equipment requiring special heavy transportation carriers).

The document to be provided by the Contractor, will serve to improve safety conditions for pedestrians. The plan is to be used by workers but also by local communities to raise public awareness about existing conditions, current practices and new initiatives aimed at improving pedestrian safety.

The plan should be promoted by all project personnel during travel to and from the workplace, and during operation of project equipment on private or public roads.

9.4.2.2. PLAN CONTENTS

Based on the general objectives, the proposed plan shall:

- Examine existing pedestrian traffic control devices;
- Review pedestrian and traffic collision history linked to Nurek HPP activities to identify dangerous areas for improvement;
- Identify initiatives to improve safety for pedestrians within the existing transportation network;
- Identify access and circulation alternatives to provide a proactive approach to pedestrian safety in crossed cities/villages and in the project area;
- Propose an achievable implementation plan.

Some preventive measures are proposed in the following chapter.

9.4.2.3. PROPOSITION OF PREVENTIVE MEASURES

Prevention and control of traffic related injuries and fatalities should include the adoption of safety measures that are protective of project workers, road users and pedestrians.

Measures to reduce the risk of traffic accidents in the project site include the following:

- Training and licensing industrial vehicle operators in the safe operation of specialized vehicles;
- Ensuring drivers undergo medical surveillance;
- Ensuring moving equipment with restricted rear visibility are fitted with audible back-up alarms;
- Establishing rights-of-way, site speed limits, vehicle inspection requirements, operating rules and procedures, and control of traffic patterns or direction;
- Restricting the circulation of delivery and private vehicles to defined routes and areas, giving preference to "one-way" traffic, where appropriate;
- Emphasizing safety aspects among drivers;
- Adopting limits for trip duration and arranging driver rosters to avoid fatigue;
- Avoiding dangerous routes and times of day to reduce the risk of accidents;
- Use of speed control devices (governors) on trucks, and remote monitoring of driver actions;
- Regular maintenance of vehicles and use of manufacturer-approved parts to minimize potentially serious accidents caused by equipment malfunction or premature failure.

Where the project may contribute to a significant increase in traffic risks along access roads, measures may include:

- Minimizing pedestrian interaction with project vehicles;
- Collaboration with local communities and relevant authorities to improve signage, visibility and overall safety of roads, particularly along stretches located near schools or other locations where children may be present. Collaborating with local communities on education about traffic and pedestrian safety (e.g. school education campaigns);
- Coordination with emergency responders to ensure that appropriate first aid is provided in the event of accidents;
- Using locally sourced materials, whenever possible, to minimize transport distances. Locating associated facilities such as worker camps close to project sites and arranging worker bus transport to minimizing external traffic.

9.4.3. ESMP03: Emergency Preparedness and Response Plan

An **emergency** is an unplanned event when the control of a project operation is or could be lost, leading to a situation that may result in risks to human health, property, or the environment, either within the facility or in the local community.

The Contractor should have an Emergency Preparedness and Response Plan that is commensurate with the risks of the project. This plan should treat common risk (fire, worker accidents, etc.) and specific project risk such as the risk of having to stop all running turbines so that the Nurek dam would be exposed to a critical hazard (flooding).

An Emergency Preparedness and Response Plan includes the following basic elements:

- Administration (policy, purpose, distribution, definitions, etc.);
- Organization of emergency areas (command centers, medical stations, etc.);
- Roles and responsibilities;
- Communication systems (to workers, communities notifications, media and agency relations);
- Emergency response procedures;
- Emergency resources (fire services, medical services, availability of safety resources, etc.);
- Training and updating of the Plan;
- Checklists (role and action list and equipment checklist).

For the specific risk of a release of asbestos, a release control, prevention, and countermeasure plan constituting a specific component of the Emergency Preparedness and Response Plan should be prepared. The plan should include:

- Training of operators;
- Implementation of inspection programs;
- Identification of locations of asbestos and associated activities on an emergency plan site map;
- Documentation of availability of specific personal protective equipment and training needed to respond to an emergency;
- Documentation of availability of release response equipment sufficient to handle at least the initial stages of a release and a list of external resources for equipment and personnel, if necessary, to supplement internal resources;
- Description of response activities in case of another spill, release or chemical emergency.

- For the risk of turbines switching off due to an incident (see

Impact n°I11: Increase of the operational issues, chapter 0.), the Contractor should in consultation with the Operator prepare a dedicated chapter that deals with this situation and that aims to resolve the problem in the best conditions and deadlines.

The Plan should include:

- The identification of all potential causes of turbine switch off;
- Identification of interface area between 2 or more turbines in each unit to be refurbished;
- The creation of a dedicated intervention unit of electricians with the participation of the Operator;
- Description of response activities (intervention process);
- The documentation regarding refurbishment activities: work-permit and all documentation describing Contractor’s past activities/actions;
- A list of materials and tools to be ready on site in the case of an intervention.

9.4.4. ESMP04: Work permit

During the refurbishment, intervention on turbine, generator or other electrical devices may lead to potential operational issues (“

Impact n°I11: Increase of the operational issues", see Chapter 0).

To prevent this risk, all interventions to be made on the turbine, generator or other electrical elements must follow a strict procedure. The Contractor shall establish and use a Work-Permit system for dismantling and rehabilitation (disconnection, connection of the unit) work carried out by the Contractor.

A Work-Permit has to be developed by the Plant personnel, and approved by the Contractor.

The Work-Permit system shall ensure that proper planning and consideration is given to the risks of a particular task. The Work-Permit system shall be a formal written system which essential features are:

- Clear identification of who may authorize particular jobs (and any limits to their authority) and who is responsible for specifying the necessary precautions;
- Training and instruction in the issue and use of permits;
- Monitoring and auditing to ensure that the system works as intended.

Objectives and functions of such Work-Permit system shall be:

- Ensuring the proper authorization of designated work;
- Making clear to operators carrying out the work the exact identity, nature and extent of the task and the hazards involved;
- Specifying any limitations on the extent of the work and the time during which the task may be carried out;
- Specifying the precautions to be taken;
- Ensuring that the person in charge of the plant, a unit or an installation is aware of all the work being done;
- Providing a record showing that the nature of the work and the precautions needed have been checked by an appropriate person;
- Providing for the suitable display of permits;
- Providing a formal hand-back procedure to ensure that any part of the plant affected by the work is in a safe condition and ready for reinstatement.

A close communication between the Contractor and the Operator before and during the refurbishment can also be a key measure to prevent switch off risk.

9.4.5. Environmental flows

Given the existing operation rules and principles, during and after the refurbishment, the project has no impact on the downstream discharge at a daily time-scale (see paragraph 5.3.1). Therefore no environmental flows are required given the fact that the water discharge is not modified.

9.5. Execution and monitoring of ESMP programs/activities

9.5.1. Stakeholders

The stakeholders mapping for the project as a whole is detailed in section 7.3.1.

As for the specific issue of execution and monitoring of ESMP programs/activities, the main stakeholders are:

- The Ministry of Energy and Industry;
- BT;
- The Contractor;
- Affected Communities.

9.5.1.1. MINISTRY OF ENERGY AND INDUSTRY

The Ministry of Energy and Industry is the public authority responsible for the implementation of unified state policy and regulation in the sphere of fuel and energy, natural resources, as well as irreplaceable resources of energy, regulation of industry, defense industry, engineering and technology, production of building materials, food and work process. The Ministry heads, coordinates and supervises the activity of executive organs, public services of energy control under executive bodies, workshops and institutions of the ministerial system.

The overall activities of the Ministry are subordinated to the Constitution of the Republic of Tajikistan (RT), constitutional laws of the RT, laws of the RT, international bills acknowledged by RT, resolutions of Majlisi Milli and Majlisi Namoyandagon of Majlisi Oli of the RT, decrees of the President of the RT and decrees of government of the RT. The activity of the Ministry is also connected with other local executive bodies, NGOs and other enterprises[26].

9.5.1.2. BARQI TOJIK

Barqi Tojik is the national integrated power company of Tajikistan. The Open Joint Stock Holding Power Company (OSHPC) Barqi Tojik was established by Resolution of the Government of the Republic of Tajikistan dated November 3, 2001 n°492 and reregistered by Resolution of the Government n°537 dated October 31, 2008.

The owner of the Nurek HPP refurbishment project is the Republic of Tajikistan through OSHPC “Barqi Tojik”.

The Owner will have the overall responsibility for the project’s compliance with national legislation, regional and international agreements, treaties and conventions and international guidelines and best practices for environmental and social performance aspects.

[26] www.minenergoprom.tj/ministerstvoe.php

The operation of Nurek HPP is under the responsibility of a dedicated unit of Barqi Tojik, hereafter called Nurek Operation Unit (NOU). Project Management Consultant (PMC), which has already been hired by BT, will be conducting oversight to ensure Contractors' compliance with the requirements of ESMP.

9.5.1.3. CONTRACTOR

The Contractor is the company responsible for the refurbishment work. Its name is not yet known.

9.5.1.4. COMMUNITIES

Concerned communities are those that may be impacted by the project, e.g. with the augmentation of the pedestrian and traffic risk or the water quality degradation.

By extension, communities can also include downstream countries that may be impacted by the project.

9.5.2. Organization and responsibilities

The Project Owner is committed to government authorities and/or lenders in charge of the EIA validation to the implementation of environmental measures. The Project Owner is responsible for the implementation and monitoring of environmental and social measures.

The Project Owner should provide all the resources the support necessary to ensure that the ESMP measures are met.

The Contractor shall be responsible for carrying out the EHS plan.

9.5.2.1. SUPERVISION: THE PROJECT OWNER AND PMC

Through the PMC, the Project Owner shall be responsible for the execution of the ESMP measures. In this project, PMC has been hired and has a qualified environmental specialist. The PMC will be in charge of the supervision, control and monitoring work, including the following responsibilities:

- Review and approval of the Contractor's EHS Plan and other sub-ESMP's plan (Pedestrian and Traffic Safety Plan, Emergency Preparedness and Response Plan, etc.);
- Verify labor working conditions that have to be compliant with national regulations and international standards;
- Check the staff training of the contractors to ensure a continued environmental performance;
- Monitor and evaluate ESMP measures/programs (results, progression, etc.) with progress reports provided by the Contractor;
- Carry out regular EHS inspection visits on the refurbishment site and along access road. These inspections and control visits can be based on guidelines already given in the measure's description for Contractors (see chapter 9.4);
- Assist in proposing corrective measures in case non-compliance has been observed with any of the conditions;
- Propose ESMP measures/programs modifications/evolutions if necessary;

Apart from the validation responsibility, the Project owner should carry out the following tasks with the support of the Environmental and Social Safeguards Consultant to be hired by BT. This will also help BT to start building in-house safeguards capacity for planning and implementing similar projects.

- Collaborate on daily basis with the PMC;
- Put in place an internal reporting system such as:
  - Preparing monthly and quarterly reports for the attention the Project Owner and lenders based on the contractor's reports and on own activities;
  - Preparing additional reports according to specific conditions or events;
  - Reporting as soon as possible to the Contractor as well as to the Project Owner in case a serious non-compliance;
  - Alerting the Project Owner and Contractor in case of an emergency.
- Plan and carry out an internal and external outreach with communication actions deemed necessary (see Chapter **Error! Reference source not found.** "SEP");
- Keep informed of any developments that could influence the content or implementation of ESMP measures;
- Keep abreast of expectations and problems occurring within the communities and workers;
- Coordinate all objectives and work programs. As such, the Project Owner shall organize coordination meetings, consultations or training if required;

9.5.2.2. IMPLEMENTATION: THE CONTRACTOR

The Contractor receives delegation from the Project owner for the detailed design and implementation of the socio- environmental plans relating to the project, and in particular the EHS plan, the Pedestrian and traffic safety plan, and the emergency preparedness plan.

The Contractor shall be responsible for the proper implementation of the ESMP, including:

- The provision to the Project Owner of the EHS Plan and other sub-ESMP's plans (Pedestrian and Traffic Safety Plan, Emergency Preparedness and Response Plan, Hazardous waste Management Plan, etc.);
- The implementation of the ESMP measures and programs;
- The assurance of proper implementation of all measures and programs by sub-contractors and workers on site;
- The provision to Project owner, of reports regarding the achievement of the objectives of measures and planning;
- The preparation of periodic reports for the attention of the Project Owner:
  - Monthly Progress and Monitoring Report should provide a statement on all monitoring activities, and on any specific events;
  - Quarterly Reports should summarize all observations during the period;
  - Additional reports according to specific conditions or events;
- A close communication with Project owner's team (NOU) during operation. The Contractor shall report emergencies as soon as possible to the Project owner.

The Contractor shall have its own EHS unit to comply with the contract and to achieve all the objectives given by the Project owner. This unit shall be composed of, at a minimum, one HS specialized Environmental engineer.

It is the Contractor's responsibility to convey to its employees and subcontractors the guidelines/measures for the environmental, health and safety prevention and ensure that they apply them.

9.5.3. Monitoring

According to the World Bank Group OP 4.01 Appendix C, the Project owner is committed to monitor environmental conditions and implemented measures during refurbishment. Environmental monitoring during project implementation aims to provide information about key environmental aspects of the project, particularly the environmental impacts of the project and the effectiveness of mitigation measures. Such information serves as a basis for evaluating the success of mitigation as part of project supervision, and allows corrective action to be taken when needed.

In order to monitor the performance of measures and to conduct periodic audits, the Contractor must propose a Monitoring and Evaluation Plan in its Environmental Health and Safety Plan. This plan will define:

- Measures justifying the monitoring and / or evaluation;
- The parameters which will be monitored and indicators (quantitative limits, level, etc.) to be used to analyzed these parameters;
- A brief description of the evaluations to be made;
- The institution in charge of monitoring and / or evaluations, specifying whether it is monitoring or internal /external evaluation;
- How the results will be collected, processed, stored and communicated;
- How the results will be used (e.g. Record of non-compliance, improvement of HSE measures, penalties, etc.).

9.5.3.1. P01: EHS MANAGEMENT AND MONITORING PLAN

The Project owner ensures the formulation of its environmental requirements during the contracting phase with the Contractor. In particular, the Contractor presents its approach and modalities of implementation of the various Environmental, Health and Safety plans, in accordance with measures developed in Chapter 9.4 and Project Owner's and Lender's requirement expressed in the ToR of the bidding phase.

The Owner supervises the activities of the Contractor during the project in order ensure that the Contractor is in compliance with the EHS requirements..

The main responsibilities of the Owner in relation to the supervision of the Contractor have been mentioned in Chapter 9.5.2.1.

The monitoring of Environmental-Health-Safety plans requires establishing monitoring indicators. It will be necessary to continue monitoring some environmental and social components during the construction and operational phases, given the project's impacts (and measures / programs implemented), . The proposed indicators are presented in the table below. Specific targets, levels of each criterion should be proposed by the Contractor in its Monitoring and Evaluation Plan. These should respect national legislation (see Table 49 and Table 50) and international safeguards policies, including those of the Owner and Lenders.

Table 48 - Indicators for monitoring and evaluation of the ESMP measures

Measures	Monitoring indicators	Evaluation criteria
ESMP01: Environmental Health and Safety Plan	• Environmental Health and Safety Plan existence • Environmental Health and Safety team at Contractor side	• Existence of noise in residential areas (monthly monitoring) • Monitoring landfill waste (monthly monitoring) • Water flow downstream during rehabilitation (weekly monitoring) • Number of HSE training on site (monthly monitoring) • Number of road accidents (continuous monitoring) at the project site • Number and type of accidents at work (continuous monitoring) • Number of days absent staff (monthly monitoring) • Knowledge of security measures and rules by workers and the surrounding population (at the beginning of construction and the arrival of each new employee) • Existence response procedures in case of accident and emergency facilities (Emergency Preparedness and Response Plan) • Number of complaints registered from workers, their families and local people (continuous monitoring) • Number of briefings on available jobs (continuous monitoring); etc.
	• Air quality monitoring (asbestos dust in particular) • Establishment of a water quality monitoring plan • Physical and chemical parameters of the water quality	• Number of samples / analysis • Biological, bio-chemical components concentrations and physical characteristics • Presence of dead fish (upstream and downstream) • Number of complaints of surrounding populations on water quality upstream and downstream (continuous monitoring) • Operation of wastewater treatment systems; etc.
ESMP02: Pedestrian and traffic safety plan	• Pedestrian and traffic safety plan existence	• Number of traffic/pedestrian accidents outside the project site (continuous monitoring) • Number of complaints and claims of local people about traffic and road safety • Number of outreach meetings about road hazards • Number of signs, speed bumps installed • Numbers controls performed on vehicles and Results • Number of controls on drivers and results
ESMP03: Emergency Preparedness and Response Plan	• Emergency Preparedness and Response Plan existence	• Number of accidents / incidents related to dam • Knowledge of evacuation measures by the population • Number of updating the plan and schedule • Number of communication actions around this plan • Number of briefing • Number and diversity of proposed training • Controls facilities, map materials and procedures

Measures	Monitoring indicators	Evaluation criteria
		• Number of completed safety/emergency exercises
ESMP04: Work permit	• Use of the work-permit system	• Making a list of work permits to perform • Number of work permits drafted and signed by the two parties • Number and results of the controls performed to verify the existence and proper application of work permit

Table 49 - Air Quality Standards for selected pollutants

Pollutant	Tajikistan Standard mg/m^3 (maximum allowable concentration)	IFC/World Bank Guidelines / Standards □g/m^3
Particulates	0.15	PM 2.5 10 (1 yr) PM 2.5 25 (24 h) PM 10 20 (1 yr) PM 10 50 (24 h)
Nitrogen oxide (NO)	0.06	-
Nitrogen Dioxide (NO_2)	0.04	40 (1 yr) 200 (1 hr)
Sulfur Dioxide (SO_2)	0.05	20 (24 h) 500 (10 min)

Table 50 - Water Quality Standards for some selected indicators

Indicators	Tajikistan requirement for surface water (mg/l)	IFC/World Bank Guidelines / Standards (or treated sanitary wastewater)
pH	6.5 – 8.5	6 – 9
O_2	4.0 in winter 6.0 in summer	-
BOD	3.0	30
COD	-	125
NO_3^-	40	Total nitrogen 10
Cl^-	300	-
SO_4^{2-}	100	-
CrVl	0.100	-
Pb	0.100	-
Phosporus	-	Total Phosphorus 2
Oil and petrochemicals / grease	0.05	10
Total coliform bacteria	-	400/100ml

Note: Current national and regional monitoring of ambient air quality and noise level is ensured by, respectively:

- The Committee on Environment Protection. Agency on Hydrometeorology Measures conducts baseline survey using control station on quality of atmospheric air (the stations ate located far from the Project, in Tursunzade, Dushanbe, Khujand, Kurgan-tyube, and Spitamen), source measurement using "Atmosphera" mobile laboratory. 6 ingredients are being measured (dust/odor, SO_2, nitrogen oxides, Nitrogen dioxides, formaldehyde and fluorine);
- The Ministry of Health and Social Protection of the Population – its district subdivision – Sanitary and Epidemiological Service, depending on the information obtained, as per the Law of the Republic of Tajikistan dated 8 December 2003, No 49 "On ensuring Sanitary and Epidemiological Safety of the Population".

As far as the **Electric and Magnetic Fields (EMF)** are concerned (cf. section 0), monitoring measures can be implemented for both workers and local communities. They can include:

- Surveys of exposure levels in HPP and use of personal monitors during working activities;
- Identification of safety zones to differentiate between work areas with expected elevated EMF levels compared to those acceptable for public exposure, limiting access to properly trained workers;

- Check that exposure limits to electric and magnetic fields published by the International Commission on Non-Ionizing Radiation Protection (ICNIRP) are respected (see Table 51).

Table 51 – Exposure limits to EMF

Frequency	Occupational Exposure		General Public Exposure	
	Electric Field (V/m)	Magnetic Field (□T)	Electric Field (V/m)	Magnetic Field (□T)
50 Hz	10,000	500	5,000	100
60 Hz	8,300	415	4,150	83

Source: ICNIRP (1998): "Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (up to 300 GHz)"

9.5.3.2. P02: HYDROLOGICAL MONITORING

During the refurbishment, in order to verify that the project will not impact downstream hydrology and to identify any non-expected downstream hydrological impacts (changes of flow regime), the Project owner should implement a close hydrological monitoring in association with the Contractor. In case of hydrological modification, it will be possible to analyze the compliance of the identified impacts with other downstream water uses (agriculture, electricity, minimum flow in the Amu Darya, etc.).

Water flows downstream of Nurek HPP (turbines + spillways) will be obtained through the usual operational facilities of Nurek HPP.

Discharge measurement, or stream gauging, requires special equipment and, sometimes, special installations. The measurements should be made by an agency that has staff with expertise in the techniques of hydrological survey. The most accurate method is to measure the cross-sectional area of the stream and then, using a current meter, determine the average velocity in the cross-section. If a current meter is not available, a rough estimate of velocity can be made by measuring the time required for a weighted float to travel a fixed distance along the stream.

For best results, the cross-section of the stream at the point of measurement should have the following ideal characteristics:

- The velocities at all points are parallel to one another and at right angles to the cross-section of the stream;
- The curves of distribution of velocity in the section are regular in the horizontal and vertical planes;
- The cross-section should be located at a point where the stream is nominally straight for at least 50 m above and below the measuring station.

Bridges are preferred as stream gauging stations because they usually allow easy access to the full width of the stream, and a water level indicator can be fastened to a bridge pier or abutment. Aerial cableways are often located at places where characteristics of the stream cross-section approach ideal conditions. However, they necessitate a special installation, and this is often impractical for a water quality monitoring team. Velocity measurements made from a boat are liable to yield inaccurate results because any horizontal or vertical movement of the boat will be identified as velocity by the current meter. In shallow streams the water velocity close to the boat will be affected and this may distort the meter readings.

Floats should be used for velocity measurement only when it is impossible to use a current meter. A surface float will travel with a velocity about 1.2 times the mean velocity of the water column beneath it. A partially submerged float made from a wooden stick with a weight at its lower end (so that it floats vertically) may be used. The velocity of a float of this type will be closer to the mean velocity and a correction factor of about 1.1 is appropriate if the submerged part of the float is one-third to one-half the water depth. The velocity of any float, whether on the surface or submerged, is likely to be affected by wind.

During the whole monitoring period, reports will be produced and results made available to Lenders if required, in the quarterly and yearly report.

9.5.4. Costs of ESMP implementation, monitoring and evaluation

9.5.4.1. COSTS

This chapter discusses the necessary costs for the implementation, monitoring and evaluation of environmental plans and measures. The below entities and individuals will be involved in ensuring supervision over implementation of ESMP.

- Project Management Consultant (PMC), which has an environmental safeguards specialist and Health and Safety specialist, which will be responsible for supervision of the Contractors to ensure their activities are consistent with the requirements of ESMP. BT has already signed the contract with PMC and it has already mobilized.
- Environmental and Social Safeguards Consultant of BT. BT will be hiring an individual consultant to: (a) to work on the project from BT side to oversee the quality and substance of monthly reports submitted by PMC; (b) participate in supervision missions of PMC to oversee contractor's compliance with ESMP; and (c) be responsible for functioning of GRM under the project.

The total costs of ESMP implementation were estimated as the costs of PMC's safeguards specialists, the Environmental and Social Safeguards Consultant to be hired by BT, and the cost of technical assistance under the project, which will be used for implementation of ESMP and capacity building of BT to strengthen its safeguards capacity; as well as other costs.

Regarding personnel costs, the needs of the ESU to prepare, revise, monitor and evaluate Contractor activities are established by reference to the projected schedule shown in Appendix 2.

Phasing is the following:

- Preparation phase of 3 months before the start of the refurbishment work. This phase includes the preparation of bidding documents for procurement of the EPC Contractor, review and evaluation of bids, and signing and effectiveness of the contract.
- The implementation of the ESMP and Contractor control over a period of 10 years, from the beginning of the construction works.
- The monitoring and evaluation of the ESMP during a 3 month period after the completion of the rehabilitation.

Staff and Travel Costs of PMC

The PMC environmental and Health and Safety specialists' cost is estimated at US$1,500,000 for the entire 10 year duration of the project. This includes the staff time and field visits required during implementation. The cost is estimated assuming those specialists will be visiting the site once a month and submitting reports on compliance of works with requirements of ESMP.

Table 52 - Staff resources for PMC (Person-month)

Function	**Total Pers.-month**
Environmental Specialist	20
Health and Safety Specialist	20
Total	**40**

The staff costs are estimated at US$600,000 for total duration of the project and the travel costs of those two specialists (assuming international experts) are estimated at US$800,000. The travel costs were derived assuming travel to the site once a month for two specialists during the entire 10-year implementation period. Additionally, PMC will be providing required training for relevant BT staff, and contractor staff (upon necessity, which will be established after commencement of civil works) on implementation and supervision over safeguards aspects of hydropower rehabilitation. The cost of such training is estimated at US$100,000 during the entire duration of the project.

Individual Safeguards Consultant of BT

BT will hire an environmental and social safeguards consultant, which will be helping BT oversee the implementation of ESMP. Although PMC has an environmental specialist, it is not sufficient for successful implementation of the project from safeguards perspective because BT does not have any in-house expertise on safeguards matters and will not be able to act on the findings and recommendations contained in PMC monthly reports. Thus, BT will hire and retain individual consultant for the entire duration of the project. The total cost of the consultant is estimated at US$240,000 during the entire duration of the project assuming this will be a local consultant with a monthly rate of US$2000.

Technical Assistance

The technical assistance to BT on safeguards is estimated at US$540,000. This includes any capacity building support, which BT may require under the project and the cost of implementing SEP:

- Cost of Consultant/NGO to conduct information sharing/public consultations during each year of the 10-year project implementation: US$300,000
    - *10 consultations, unit cost of US$30,000*
- International environmental specialist: US$100,000
    - *4 person-months, unit cost US$25,000/month*
- International flights: US$60,000
    - *20 flights at US$3,000/flight*
- Per diems, interpreter, transportation: US$60, 000
    - *120 days at US$500/day*
- Translation of reports: US$20,000

Other operating costs of BT related to ESMP

Other investment and operating costs and various expenses are estimated at US$23,000 per year, a total of nearly US$227,850.

This includes:

- Technical expertise's (laboratory analyses, sampling, etc.): US$157,500 (US$15,000/year)

- A vehicle: US$21,000 (US$2,000/year)
- Car insurance, fuel, etc.: US$42,000 (US$4,000/year)
- Computer's devices: US$5,250 (US$500/year)
- Miscellaneous equipment's: US$21,000 (US$2,000/year)

Total

The estimated operating expenditure linked to ESMP implementation are estimated at **US$2,507,850**.

9.5.4.2. IMPLEMENTATION SCHEDULE

The ESMP will be implemented throughout the project life, meaning 10.5 years.

APPENDICES

Appendix 1 - Dam safety recommended actions

(Proposed by Tractebel Engineering to Barqi Tojik in the report "Techno-economic assessment study for rehabilitation of Nurek hydro power plant and dam safety provisions", Volume II Chapter 8 – "Recommended Actions and Cost Estimate")

Abbreviations: BT: Barqi Tojik TA: Technical Assistance by Engineering Consultant

Recommendation		Reference	PFM Number	Priority
Technical documentation				
TD1	Gather technical information on the dam and its monitoring system and updated condition of the monitoring system in a dedicated report.	CHAPTER 2		2
TD2	Secure the access to the main documents related to dam safety (gather all documents relevant for the Dam Safety in a specific file in paper and soft copy).	CHAPTER 2		2
TD3	Draw a set of modern synthetic drawings (Autocad or similar) of the dam and its appurtenant structures. The drawings should include the layout of the whole monitoring system. Autocad or similar with suitable computer equipment should be used by the Hydrotechnical Department for this purpose. Show on a drawing the actual water routing and check if there are redundancies (flows measured at several places).	CHAPTER 2		2
TD4	Create a digital database including all geological and geotechnical data. Efforts are necessary in a first step to recover the results of the investigations carried out at the design stage.	CHAPTER 5		2
Organization of the surveillance				
OS1	Name a competent and specialised entity providing continuous technical assistance for the surveillance of the dam and its appurtenant structures at Level 2 (Detailed yearly analysis of the monitoring data and after special events such as floods or earthquakes or unusual condition detected by visual observation or monitoring by specialists) and at Level 3 (5-year detailed analysis of the monitoring data, inspections and associated reports by Experts).	CHAPTER 2		1
OS2	Organize for the Team in charge of the dam surveillance a visit of a large dam with up-to-date surveillance organisation and monitoring system such as Birecik (Turkey)	CHAPTER 2		2

Recommendation		Reference	PFM Number	Priority
Electrical Supply of Dam, Water Intake and Spillways				
EL1	Establish a specific procedure mentioning the frequency and the conditions of periodic tests of the mobile generator located at the Water Intake. Barqi Tojik confirms that such procedure exists and is in application.	CHAPTER 2		Completed
EL2	Replace the Medium Voltage (MV) cables (6kV) of the 3 electrical loops which supply the spillways, the intake and dam equipment also with allowance for significant displacements due to strong ground motions.	CHAPTER 2 CHAPTER 7	N3, F1, E3	1
EL3	Install a new diesel generator on top of Spillway Intake (or in the Bottom Spillway Gate Chamber?)	CHAPTER 7	E3	2
EL4	Replace transformers and electrical cubicles which allow to supply and control water intake equipment, spillways equipment, and dam equipment.	CHAPTER 2		2
Hydro-electromechanical Equipment of dam tunnels				
HE1	Make available the procedure of Surface Spillway radial gates operation, tests and maintenance	CHAPTER 7	N7	1
HE2	Go on with maintenance and tests and associated records of Bottom and Surface Spillway radial gates.	CHAPTER 7 CHAPTER 2	N9, N7, N2	1
HE3	Install emergency drainage pumps for the concrete plug of the dam	CHAPTER 7	N3	1
HE4	Install a new alarm with transmission to the HPP control room signalling drainage pumps of the dam are not functioning	CHAPTER 7	N3	1
HE5	Install sensor detecting high water level in the manholes gallery (with lower penstocks access covers) with an alarm transmitted to HPP control room	CHAPTER 7	N8	1
HE6	Install equipment to give the possibility to manually open the radial gates of Surface Spillway in case of emergency with no electrical supply.	CHAPTER 2		1
HE7	Install equipment to give the possibility to manually open the radial gates and emergency gates of Bottom Spillway in case of emergency with no electrical supply.	CHAPTER 2		1

Recommendation		Reference	PFM Number	Priority
HE8	Establish detailed maintenance program for hydro-electromechanical equipment and keep record of maintenance works performed. Barqi Tojik confirms that such procedure exists and is in application.	CHAPTER 2		Completed
HE9	Continue keeping record of all tests carried out with the hydro-electromechanical equipment.	CHAPTER 2		2
HE10	Replace the electrical hoists and replace the lifting cables of radial gates of Surface Spillway	CHAPTER 2		2
HE11	Rehabilitate the gantry crane of Surface Spillway	CHAPTER 2		2
HE12	Rehabilitate hydraulic servomotors of emergency gates and radial gates of Bottom Spillway and replace their hydraulic power units	CHAPTER 2		2
HE13	Replace electrical hoist of maintenance gate of Bottom Spillway	CHAPTER 2		2
HE14	Replace the pumps of the two drainage stations with their electrical equipment (level sensors, electrical cabinets…)	CHAPTER 2 CHAPTER 7	N3	2
HE15	Implement the possibility to operate the intake gates from the HPP control room	CHAPTER 2		2
HE16	Rehabilitate the electrical hoist of intake gates and replace the lifting cables	CHAPTER 2		2
HE17	Install a level sensor with a permanent transmission of the water level to the HPP control room	CHAPTER 2		2
HE18	Perform detailed inspection of lower penstocks covers and covers rehabilitation.	CHAPTER 7	N8	2
HE19	Replacement of the HPP drainage pumps (with spare pumps)	CHAPTER 7	N8	2
HE20	Possibility to close intake gates from the HPP control room in case of emergency.	CHAPTER 7	N8	2
Monitoring instruments				
MI1	Get two new reading devices to secure the reading of the vibrating wire sensors in case the one used today gets broken. This recommendation is valid even if the automation of the monitoring system is considered (in order to keep a possibility of reading the sensors manually).	CHAPTER 2		1

Recommendation		Reference	PFM Number	Priority
MI2	Global diagnosis of the VW sensors and piezometers to be carried out by a specialized company, followed by repair works whenever possible (clean plugged piezometers, maintain twin tubes, calibrate doubtful manometers).	CHAPTER 2 CHAPTER 4		2
MI3	Complete monitoring of water table in foundation Replace some piezometers in the foundation under the core D/S grout curtain and add new ones from the galleries inside the plug or the grouting galleries. Add some piezometers in the foundation under the downstream shoulder from tunnels 6-TC and 8-TC. Reinforce the grid of piezometers in the banks for a closer monitoring D/S the grout curtain/axis of dam and further D/S.	CHAPTER 7 CHAPTER 4 CHAPTER 4 CHAPTER 4	A4, A5	2
MI4	Periodically calibrate the manometers.	CHAPTER 2		2
MI5	Replace the 3 inverted pendulums out of order in the Power Intake Tower. Resume monitoring and enter the data in the database.	CHAPTER 7 CHAPTER 4	N1	1
MI6	Monitor the largest reservoir rim landslides. In particular, resume monitoring of reservoir rim landslide areas no. 6, 9, 13 and 14 (monitoring stopped in 1989, characteristics of clayey siltstones of no. 9 not studied). Study and monitor new instabilities triggered after the survey carried out in 1977-1978.	CHAPTER 7 CHAPTER 5	N4	2
MI7	Improvement of monitoring of the downstream slopes and spillway tunnels: Inclinometers across the sliding plane and piezometers, automated 3D crack sensors in spillway and transport tunnels. Monitor the landslides with alarms and protocols for different alert levels such as an alarm when the displacements of 3D crack sensors reach a given speed.	CHAPTER 7 CHAPTER 4 CHAPTER 2, CHAPTER 5	N5	2
MI8	Add benchmarks in the potentially unstable zones on Left and Right Banks DS the dam Resume monitoring of possible unstable zones DS the dam, Store the data in the database.	CHAPTER 4		1

Recommendation		Reference	PFM Number	Priority
MI9	Upgrade seismic monitoring with new digital 3D-accelerometers.	CHAPTER 3		2
Monitoring measurements				
MM1	Continue monitoring of core with special attention to profiles P0, P4, P5, P11, P25, P27, P14 to P18.	CHAPTER 7	A1	2
MM2	Regularly weight and analyse deposits of upstream weirs in dam and plug to detect core erosion. Store the information in the database. OS?	CHAPTER 7 CHAPTER 2	A1	2
MM3	Reassess the capacity of weirs and measuring conditions. If necessary, replacement of weirs and measuring tools.	CHAPTER 2		2
MM4	Measure the discharge at each significant leak or drainhole.	CHAPTER 4		2
MM5	Keep gathering more geodetic data for Water Intake and Surface Spillway and collect those more often (at least once a year) so as to get longer time series of reliable data to confirm the drifts.	CHAPTER 4		2
MM6	Resume the monitoring with the jointmeters of the Water Intake.	CHAPTER 4		2
MM7	Carry out periodic checks of the differential displacement which could lead to the jamming of the gates of Water Intake and Surface Spillway.	CHAPTER 4		2
MM8	Continue surface monitoring of geodetic targets over the downstream slope area.	CHAPTER 7 CHAPTER 5	N5	2
MM9	Develop complementary functionalities to the monitoring database: Collecting the data on a pre-defined frequency, Reading the remote sensors on demand, Validating the collected data, Comparing with limit values, Adding new sensors, Defining pre-programmed graphs, Adding drawings (plan views, horizontal cross sections, vertical profiles) showing location of sensors and the corresponding monitoring data, Tools for monitoring analysis: assessment of effective stress, hydraulic gradient, drawing of isolines, statistical tools, etc… Panda database being no more developed by EDF, change for another monitoring database with the above functionalities.	CHAPTER 4		2

Recommendation		Reference	PFM Number	Priority
MM10	Store all monitoring data in the database	CHAPTER 4		2
MM11	Following sensors could be automated: a choice of wire sensors, main weirs for seepage flows, upstream and downstream water levels, new Vibrating Wire piezometers, and the monitoring - with alarm - of triangular block landslide shearing the Bottom Spillway tunnel.	CHAPTER 4		2
Visual Observation				
VO1	Regular inspections of Surface Spillway chute to detect large rocks falls possibly blocking the chute	CHAPTER 7	N6	1
VO2	Regular inspections of reservoir rim landslides and analysis of recent aerial images. Inspections of reservoir rim landslides after heavy rains, snow melting and earthquakes.	CHAPTER 7	N4	2
VO3	Go on with visual observation of the worn out joint No. 7 of gallery II.	CHAPTER 2		2
VO4	Regularly inspect the aeration ducts of Surface and Bottom Spillways and keep them in working order.	CHAPTER 7	O5	1
VO5	Regularly inspect the inside of Spillways hydraulic tunnels and chutes to detect sign of cavitation and damage to lining of concrete. Repair if needed.	CHAPTER 7	O5	2
Investigations and surveys				
IS0	Perform detailed inspection of Surface and Bottom Spillway tunnels to assess condition of lining. *This inspection (which could not be carried out so far by the Consultant) is of utmost importance considering the high speed of the flow and the risk of cavitation and in the fracture area crossed by the sliding plane.*	CHAPTER 7	N5	1
IS1	Find documentation of construction of the dam to assess the risk of internal erosion of core due to inadequate filter	CHAPTER 7	A1	1
IS2	Check the top elevation of the core near the banks	CHAPTER 7	F2	1
IS3	Search for detail drawings of the core galleries I and II and its construction joints (and mechanical characteristics).	CHAPTER 7 CHAPTER 2	A6	1

Recommendation		Reference	PFM Number	Priority
IS4	Assess the discharge capacity from drainage tunnels to Bottom Spillway hydraulic tunnel	CHAPTER 7	A7	1
IS5	Core drilling and laboratory testing to check concrete swelling of Intake Tower, Surface Spillway Intake and Power House around discharge gates.	CHAPTER 7	N1, N2, A8	1
IS6	Search for the initial calculation note of Surface Spillway radial gates and hoisting systems.	CHAPTER 7	N7 N9	1
IS7	Continue regular inspections of the manholes gallery (with lower penstock access covers) to detect possible water ways between gallery and HPP	CHAPTER 7	N8	1
IS8	Perform a bathymetry of reservoir and assess impact of sedimentation on ability to pass the floods	CHAPTER 7	O1	1 – under progress
IS9	Perform detailed inspection of Surface and Bottom Spillway radial gates, hoisting mechanism and covers of bottom gate chamber.	CHAPTER 7	N9	1
IS10	Assess the compaction of core behind galleries I and II through geophysical survey (sonic)	CHAPTER 7	A2	2
IS11	Investigate (on drawings) the possibility for the water of going inside the core through the penetration sleeves seen in the Gallery II (855) and in other core galleries if any.	CHAPTER 2		2
Engineering Studies				
ES0	Investigate and assess Glacial Lake Outburst Floods (GLOFs) based on glacial lakes 'inventory and analysis of GLOF's hydrographs	CHAPTER 7	F5	1
ES1	Simulation of flood routing without any turbined flow to assess for which return period the core is overtopped	CHAPTER 7 CHAPTER 7	N1 E2	1 1
ES2	Simulate the scenario to check the ability to pass floods without Bottom Spillway.	CHAPTER 7	E8	1
ES3	Define a rule curve based on simulations to reduce the risk of overtopping the dam for a flood exceeding 1/10000 flood. Before flood period, lower the reservoir water level to anticipate compensation for loss of discharge capacity in case Surface Spillway gates are jammed.	CHAPTER 7	F2 N2 E4, E5,	1

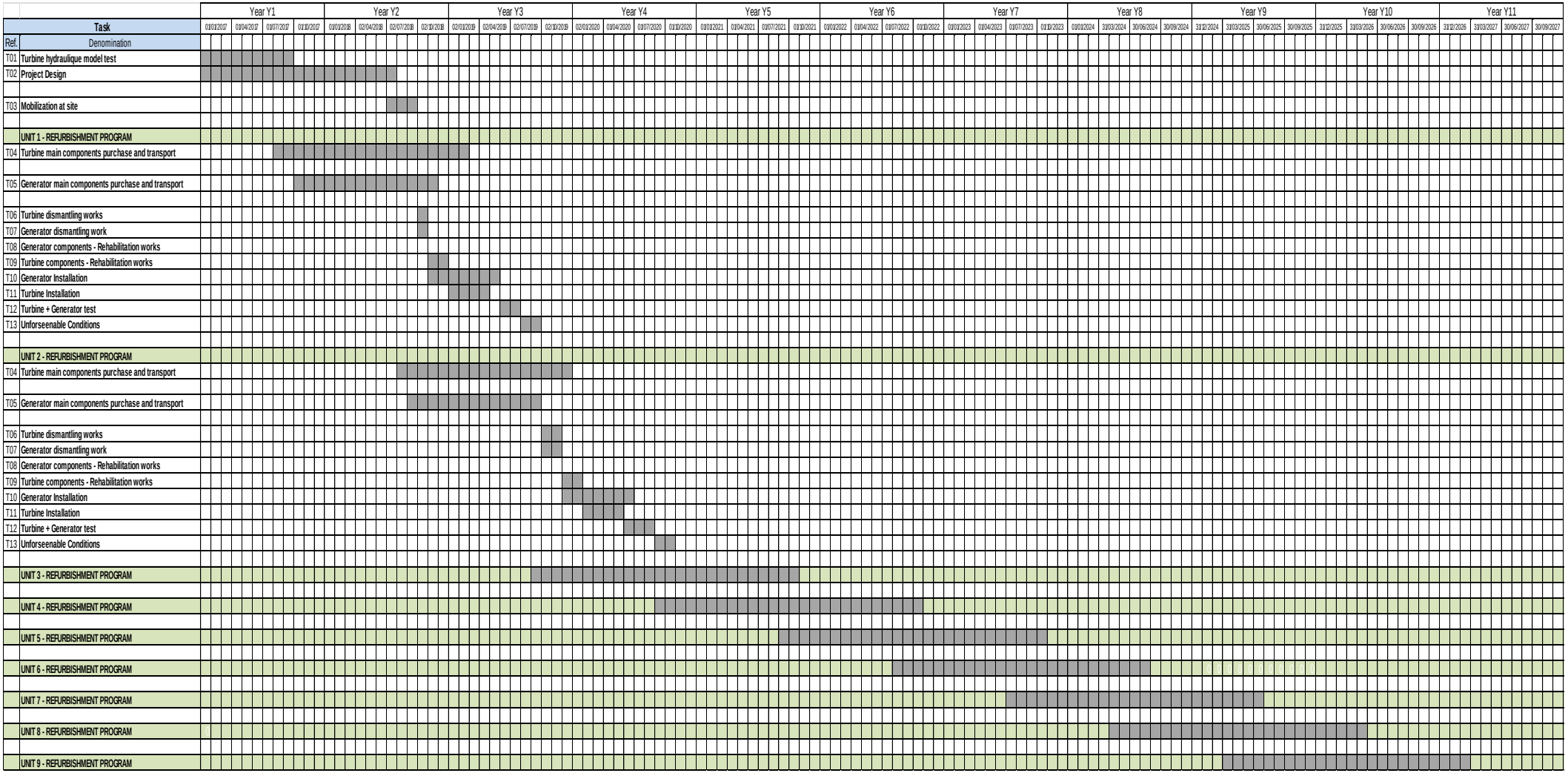
Recommendation		Reference	PFM Number	Priority
	May need to reduce the reservoir level to reduce risk of overtopping in post-earthquake condition. Assess the risk of a flood occurring mid-July.		E7, E8	
ES4	Enhance the flood forecasting	CHAPTER 7	F2	1
ES5	Investigate spillway options for an additional spillway	CHAPTER 7	F2	1
ES6	Update assessment and inventory of landslides on the reservoir rim in order to determine the maximum height of waves.	CHAPTER 7	N4	1
ES7	Perform stability calculations of slopes possibly shearing or blocking Bottom Spillway tunnel and chute in normal and seismic condition	CHAPTER 7	E8, N5	1
ES8	Check Surface Spillway radial gates design taking into account the current thickness and hoisting mechanism. Check Bottom Spillway radial gates design.	CHAPTER 7	N7, N9	1
ES9	Check the compatibility of filter material with core material and with shoulder material.	CHAPTER 7	A1, A3	1
ES10	Assess the limit gradient possibly leading to erosion of dam foundation	CHAPTER 7	A4, A5	1
ES11	Check the maximum admissible deformation (opening and shear) of seals of core galleries 1 and 2	CHAPTER 7	A6	1
ES13	Assess rise of RWL due to Rogun cofferdam break	CHAPTER 7	F3	1
ES14	Update seismic hazard assessment	CHAPTER 7	E4, E5, E7, E8	1
ES15	Check seismic design of dam, seismic belts and internal concrete elements (core galleries, plug) including settlement of dam.	CHAPTER 7	E4, E5, E7	1
ES16	Communication procedure to set up between Rogun and Nurek during Rogun construction	CHAPTER 7	F3	2
ES17	Communication procedure between Rogun and Nurek during Rogun operation	CHAPTER 7	F4	2
ES18	Adapt Nurek Emergency Action Plan during Rogun construction	CHAPTER 7	F3	2

Recommendation		Reference	PFM Number	Priority
ES19	Adapt Nurek Emergency Action Plan once Rogun in operation	CHAPTER 7	F4	2
ES20	Update the assessment of the stability of the foundation in the switchyard area.	CHAPTER 5		2
ES21	Study Nurek dam break wave propagation through 1D and 2D modelling. Draw flood inundation maps based on the results. This constitutes a necessary input of the Emergency Preparedness Plan	EPP		2
ES22	If deemed necessary by Barqi Tojik after analysis, name a competent Technical Assistant for the implementation of the Emergency Preparedness Plan following the indications of the present report.	EPP		2
Reservoir Operation				
RO1	Operate the reservoir at FSL 910 (no higher level)	CHAPTER 7	N7	1
RO2	Clarify procedure for operation in flood condition	CHAPTER 7	F1	1
RO3	Use when possible the Surface Spillway as the priority spillage option to control the risk of triggering “Triangular block” landslide shearing the Bottom Spillway tunnel and filling the tailrace under normal conditions	CHAPTER 7	N5	1
RO4	Keep the rate of drawdown between 0.5 and 1 m a day depending on the reservoir water level to control the risk of reservoir rim landslides	CHAPTER 7	N4	2
Works				
WO1	Flexible/durable sealing of damaged area of the Bottom Spillway tunnel lining	CHAPTER 7	N5	1
WO2	Install rocks falls protections above the Surface Spillway outlet	CHAPTER 7	N6	1
WO3	Remove the fallen rocks near the side walls of the Surface Spillway outlet	CHAPTER 7	N6	1
WO4	Remove the added upper part of Surface Spillway radial gates	CHAPTER 7	N7	1
WO5	Clean all the tunnels and galleries from the mud of May 2014, and in particular: tunnel 1-T,	CHAPTER 2		1

Recommendation		Reference	PFM Number	Priority
	transport tunnel to 4-TC, Tunnel 4-TC, gallery I (765), tunnel 5-TC.			
WO6	Drainage galleries across the fracture of the Bottom Spillway	CHAPTER 7	N5	2
WO7	Extend the concrete roof and side walls of the Surface Spillway outlet. In the meantime, take away the rocks fallen in the Surface Spillway chute and replace the damaged ventilation shafts in case of rockfall.	CHAPTER 7	N6	2
WO8	Have scrapers ready to remove the materials slid from the tailrace channel in post-earthquake condition to limit time during which HPP is stopped.	CHAPTER 7	E1	2
WO9	Remove the bad quality concrete and the water at the Right Bank side of the gallery II and redo the work.	CHAPTER 2		2
WO10	Increase the discharge capacity of the channel in tunnel 2-TC.	CHAPTER 2		2
WO11	Improve water tightness of the passages for cables and tubes (twin tube piezometers) into the galleries.	CHAPTER 2		2
Access and security of staff				
AS1	Secure the access to the spillways outlets by cleaning the road from the slit materials as often as needed	CHAPTER 2		2
AS2	Replace the rock fall protections on both banks over the downstream shoulder	CHAPTER 2		2
AS3	Install proper lighting in all tunnels and galleries.	CHAPTER 2		2
AS4	Install proper aeration where required. In particular: • In the tunnels and small tunnels of the plug: 7a-C, 6-C, 6a-C, 6b-C, 8-C, 8a-C, 8b-C, U/S, central and D/S small tunnels, junction tunnel in the plug and D/S small tunnel with exit of seepage (weirs B-3 PAN, B-4 PAN and B-5 PAN). • In tunnel 5-TC • In tunnel 9-TC in the Right Bank (not visited). • In Galleries II and I	CHAPTER 2		2

Recommendation		Reference	PFM Number	Priority
AS5	Install stairs with proper railing in the tunnels descending to the concrete plug.	CHAPTER 2		2

Appendix 2 - Project refurbishment work schedule*



*In this table, refurbishment tasks for unit 3 to 9 are the same as for turbine 1 and 2

Appendix 3 – Stakeholder Engagement Plan

Appendix 4 – Consultations Report by Kuhiston