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ОАХК «Барки Точик»
Республика Таджикистан

Rogun HPP ESIA

ОЭСВ РОГУНСКОЙ ГЭС

Environmental and Social Impact Assessment for Rogun Hydro Power Plant

Оценка экологического и социального воздействия для Рогунской ГЭС

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Picture on front page: View of the construction site of Rogun HPP; picture taken 2011-04-07

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LIST OF ACRONYMS AND ABBREVIATIONS

BHR	Bureau of Human Rights and Rule Of Law
BP	Before Present
BT	Barki Tojik
CC	Climate Change
CITES	Convention on International Trade with Endangered Species
CR	Critically endangered
d/s	downstream
DSR	Dam Safety Report
EFR	Environmental Flow Regulation
EHS	Environment, Health and Safety
EIA	Environmental Impact Assessment
ELOHA	Ecological Limits of Hydrologic Alteration
EMMP	Environmental Monitoring and Management Plan
EMP	Environmental Management Plan
EN	Endangered
ESIA	Environmental and Social Impact Assessment
ESMP	Environmental and Social Management Plan
EU	European Union
FGD	Focus Group Discussion
FSL	Full Supply Level
GBAO	Gorno Badakhshan Autonomos Oblast
GCM	Global Climate Models
GHG	Greenhouse Gas
GOT	Government Of Tajikistan

GPS	Global Positioning System
HC	Health Center
HPP	Hydropower Project
HH	Household
HRU	Hydrological Response Unit
ICWC	International Coordination Water Commission
IESS	Initial Environmental and Social Screening
IHA:	International Hydropower Association
IPCC	International Panel on Climate Change
IUCN	International Union of Conservation of Nature
LC	Least concern
m asl	meters above sea level
MAF	Mean Annual Flow
MOL	Minimum Operational Level
NT	Near threatened
PAP	Project Affected Person
PMF	Probable Maximum Flood
PMP	Pasture Management Plan
PoE	Panel of Experts
RAP	Resettlement Action Plan
RBT	Red Book of Tajikistan
RCM	Regional Climate Models
ROR	Run of River
RT	Republic of Tajikistan
RU	Resettlement Unit
SEA	Strategic Environmental Assessment

SIA	Social Impact Assessment
SSR	Socialist Soviet Republic
TEAS	Techno-Economical Assessment Study
TJS	Tajik Somoni
TOR	Terms of Reference
TPP	Thermal Power Plant
u/s	upstream
USD	United States Dollar
USSR	Union of Socialist Soviet Republics
VU	Vulnerable
WB	Word Bank
WCD	World Commission on Dams
WWF	World Wide Fund for Nature

EXECUTIVE SUMMARY

If you would like peace and prosperity, you should take proper care of joint water use.

Maverannakhr (the land between Amu and Syr Darya), 7th century AD (Dukhovny and de Schutter 2011:51)

The present document is the Initial Environmental and Social Screening (IESS) Report for the ESIA for Rogun HPP. Its main purpose is:

- To reach, by means of checking available information, short site visits and preliminary discussions with key stakeholders, a first appreciation of the prevailing situation in the project area.
- To identify the issues which will be (or might be) affected in any meaningful way by the project. If at this stage it already becomes clear that a certain aspect will not be affected by the project, then it will be eliminated from further work for the preparation of the ESIA Report.
- To see what information is already available on the relevant issues, and what kind of information will still have to be obtained (e.g. by specific field work) in the next steps.
- To prepare a work plan for the next steps.

It has to be pointed out clearly that this is not yet the Impact Assessment. Wherever statements on project impacts are made, these have to be considered as preliminary, and the aim of these statements is mainly to point out in which direction the efforts in the next phase will have to go. Likewise, this report does not yet propose any mitigation measures, even if in some places indications are made on what might be measures to be proposed in the ESIA.

The Report has basically the same structure as the ESIA Report will have (see Inception Report for the structure of the final report of the ESIA study).

Chapter 2 provides a short overview of the relevant legal texts and applicable standards. These can be grouped in three categories as follows:

- Laws on environmental protection and, mainly, procedure for preparation of an EIA.
- Laws on resettlement; there are two texts, one covering (voluntary) internal migration in the Republic of Tajikistan, one specifically covering resettlement caused by Rogun HPP.
- Applicable international guidelines and standards. World Bank Operational Policies are the most important ones, and their relevance was analysed shortly.

Chapter 3 describes the Project and its relevant parts.

Rogun Hydropower project is located on the Vakhsh river about 70 km upstream of the Nurek Dam and in a distance of approximately 110 km east of the capital, Dushanbe. The Vakhsh river originates in Kyrgyzstan, flows through the Pamir-Altai Mountains of Tajikistan and joins the Pyanj river after 520 km to form the Amu Darya (Darya meaning river); Pyanj and Amu Darya form the border of Tajikistan with Afghanistan. The drainage area of the Vakhsh River in Tajikistan is 31’200 km^2. Most of the river runs through very mountainous territory. At the dam site, about 340 km upstream of the confluence with the Pyanj river, the river flows through a narrow, 400-500 m deep V-shaped gorge.

Rogun HPP, as planned presently, consist of an earth dam (with a height of 335 m the highest dam in the world, 35 m higher than Nurek dam located about 60 km d/s of Rogun), of a reservoir with a total volume of 13.4 km^3, a surface of 170 km^2, and a reservoir elevation (Full Supply Level, FSL) of 1290 m asl, and an installed capacity of 3’600 MW. It will be the topmost of a cascade of hydropower projects on Vakhsh river, of which several are already existing, others in various stages of development.

Studies for Rogun HPP started in the 1960ies, and the project plans were finalised in 1978. Construction started in the 1980ies, and most of the underground structures were built during this period. After the independence of Tajikistan in 1991, works came to a halt, and in the following difficult years the condition of the built structures deteriorated. In recent years, efforts were made to reactivate the project. Presently, work is under way mostly for rehabilitating the already existing structures.

The ESIA has to be done for 2 project stages as follows:

- Stage 1 with a reservoir FSL at 1110 m asl; this situation will be maintained for several years, while dam construction will go on. The plant will already produce electricity at this stage, although with a reduced capacity.
- Stage 2 with the final dam height of 335 m and an FSL of 1290 m asl. From the start of the construction work (i.e. the start of the construction of the coffer dam) it will take about 15 years until the plant will be fully operational.

The discussions held in August 2012, and especially the presentations made by TEAS, revealed that Stage I, mainly due to the extraordinarily high sediment load carried by Vakhsh river, will not be feasible as a stand-alone project which youle be operated as such over a longer period. For this reason it was decided that no Stage I ESIA Report will be prepared as stand-alond document, However, a Stage I RAP will still be prepared.

Chapter 4 describes the study area. The most important parts are:

- The reservoir area, i.e. the area which will be submerged during the filling phase of the reservoir.
- The construction site, i.e. the site where most of the work related activities take place; this area needs to be considered specifically for impacts related to construction activities.
- The downstream area, whereby this will have to be considered as far as effects of the project on river discharge may reach.

The Chapter also provides a description of Vakhsh River and shows clearly that this has to be seen as an international river in the sense of the corresponding World Bank safeguard.

Chapter 5 provides a short overview of impact which are usually associated with or caused by a hydropower project. This serves as a basis for understanding the topics dealt with in the following sections of the Report.

Chapter 6 deals with the geology of the project area and with project effects caused by or related to the Project. Main issues discussed are:

- Slope failure and erosion: the wider project area is very prone to slope failure (landslides) and erosion.
- Salt stock: there is a large underground salt stock in immediate vicinity of the dam site. The risk this could present for the dam needs to be addressed.
- Seismicity: Rogun dam site is located in a seismically active zone. Dam design needs to take this fact into account. This is an issue mainly for the TEAS Consultant (i.e. the Technical and economic study of the project).

In Chapter 7, a short description of climatic conditions of the project area are given. The area is characterised by hot dry summers and cool winters, precipitation falling mostly in winter in form of snow. The reservoir, although not small, will not be large enough for having a noticeable effect on the local or regional climate. One potentially important issue, which was also brought forward during the first POE visit in May 2011, is climate change; in the medium and long term, this could be more decisive for the hydraulic conditions in the Amu Darya basin than Rogun dam. However, a consensus on how to approach this issue in the ESIA still needs to be reached.

Chapter 8 addresses the issue of water, which is certainly the most sensitive issue to be covered by this study.

The Project has to be seen in the context of water resource use witin the Amu Dary and Aral Sea basin. A description of wate uses in this area and of their consequences for the Aral Sea is provided. The major changes, which brought about the shrinking of the Aral Sea, have been the consgtruction of water abdution strucutes (Krakum channel) and the very extensive use of water for irrigation. Hydropower as such did not have this effect, since it does not actually consume any water.

The main question to be answered is the way in which the Project could influence river discharge, and mainly seasonal distribution of river flows. The Screening Report provides a preliminary analysis of available data and shows, in which way Nurek influenced the flows of Vakhsh river. Potential effects of Rogun will have to be analysed in the following phase, and measures will have to be developed, both for the filling phase and the operation phase of Rogun reservoir, if required, to meet water demand in the downstream area. The most important topic in this context are the possible transboundary effects of the project, mainly on Uzbekistan and Turkmenistan.

Water quality is also addressed. This, however, will not be a very critical issue, since the amount of biomass to be submerged is rather low, and since there are no important human activities in the catchment area of the reservoir which could lead to water contamination. However, water quality will be an issue during the construction phase.

The question of a need for a residual flow below Rogun dam will also have to be addressed. Important facts to be considered are the short stretch of river between Rogun dam and Nurek reservoir, the presence of a high dam (Nurek) d/s of Rogun, the absence of any water users in the affected part of the river, and the project for an additional HPP (Shurob) just u/s of Nurek reservoir; this latter would make the need for a residual flow obsolete. Based on the present situation and on applicable rules, proposals for residual flow to be considered in the hydraulic model are made.

A description of the hydraulic model to be applied by TEAS to the entire Vakhsh cascade, for simiulating the effect of Rogun HPP and for defining a regime which will not adversely affect water use interests in the downstream area, is provided. This is based on the discussions held and agreement reached on August 2011 between World Bank and the Consultants. The most important requirement is that filling and operating of Rogun HPP will have to be within the limits of water allocation to Tajikistan, which are defined in the Nukus Declaration (Protocol No. 566) and presently administered by the BVO agreements.

Chapters 9 to 11 deal with issues related to biodiversity.

Concerning vegetation, the project area is located within the Hissar-Darvaz floristic region, which covers a wide area in the central parts of Tajikistan. Its limits are the ridges of Hissar mountains to the north and the Alai mountains to the south. Westwards it extends as far as the border with the Republic of Uzbekistan. As is usually the case in mountain regions, the vegetation can be described as a number of altitudinal belts, since plant growth is influenced by temperature and precipitation. The reservoir itself is located in a belt of mainly meadows, with only little and patchy tree growth; this, however, is due to a large part to human influence, and mainly to the high grazing pressure from livestock. The remaining forests are scarce and not very dense, located mainly at elevations above the future reservoir.

The analysis of the date from field work is not completed yet, and a final statement on the impact of the Project on vegetation will be made in the ESIA report. However, given the fact that no particular and unique species or habitat types have been identified in the affected area, and that the plant species growing inside the reservoir area can also be found around the reservoir and in other parts of the country, the impact on vegetation can already be qualified as rather small.

Investigation of the fauna concentrated on mammals, birds, reptiles and amphibians. Until now two species of amphibians, 12 reptiles, 37 species of mammals and 154 species of birds have been identified in the project area. However, it has to be noted that “project area” as used here includes the entire valley along the future reservoir and not only the part of it which will be submerged. None of the species recorded is restricted to the area which will be submerged, and most of the species are rather widespread in Tajikistan.

Field work was also carried out for getting information on the fish fauna in the rivers of the project area. It has to be taken into consideration that Nurek dam was built about 30 years ago approximately 70 km downstream of Rogun dam site. This means that any fish migrations that might have occurred here from Amu Darya or the lower parts of Vakhsh river to its headwaters have already been interrupted. In addition to that, apparently a certain number of exotic species of fish were introduced into Nurek reservoir. So far, the presence of only three fish species has been confirmed for the project area, all three being species with a large range in Central Asia. While Rogun HPP will certainly have an impact on these three species, they will continue to live in the fivers upstream of the reservoir and in their tributaries. More field work will be done for getting better information on the fish fauna in the area, and a better basis for proposing mitigation measures.

The topic of Chapter 12, impact on protected areas, is related to biodiversity issues. However, potential project impacts are quite different. There is only one protected area which will be affected by the Project, the Tigrovaya Balka Nature Reserve. This is a very special floodplain ecosystem (called tugai), a landscape and vegetation type and its associated fauna which depends entirely on floodplain dynamics, i.e. on the seasonal river discharge pattern, which includes low water levels during the low flow season (winter) as well as flooding (including occasional severe floods) during the high flow season (late spring and summer). Evidence shows that Nurek had a negative effect on this ecosystem by reducing summer flows and mainly by reducing floods. It will have to be seen what the additional effect of Rogun HPP might be. There is a program under way for rehabilitating this very special ecosystem. Mitigation measures should be integrated into this program.

Chapter 13 deals with the human population of the area. This is a very central topic for the ESIA, since the population living in the reservoir area has to be resettled.

The conditions for resettlement for Rogun HPP are rather unusual due to the history of the Project. Resettlement started in the 1980ies, when construction work for Rogun started. In 1991, after independence, all work, including resettlement, came to a halt. The civil war then caused considerable and largely uncontrolled movements of populations, and during this period some people who had been resettled returned to their original places. Recently, resettlement activities were resumed. In the beginning of 2011, a new organisation was put in place. The official name of this organisation, translated from Tajik, is “Directorate of the Flooding Area of Rogun HPP”; in this report, and in the ESIA, it will usually be referred to as the Resettlement Unit (RU). This organisation is making a big effort to get the process under way again, and to clarify the situation.

When resettlement started in the 1980s, more than 5’000 people were removed from the construction area and to make way for construction of the new Rogun town. Some 3’000 people were removed from the reservoir area, mainly the Chorsada settlement, and were resettled in Dangara District; however, all the families returned to their original villages during the civil war, partly also due to unfavourable climate conditions and insufficient services. An unknown number of people were resettled locally at elevations below and above 1,290 m asl. During the civil war part of the relocated population came back to where they had been removed from, and others went elsewhere.

Resettlement is presently under way. Five areas have been identified for relocation of affected people, namely Rogun, Tursunzade City, Rudaki District, Nurobod District and Dangara District of Khatlon Region.

The ESIA has to deal with resettlement according to the two stages of the project as follows:

- In Stage 1, people will have to be resettled from elevations below 1110 m asl. This concerns only one village with close to one thousand inhabitants. In the same stage, 6 villages which are located within or very close to the construction area (the so called risk zone) have to be relocated. For these, a RAP (Resettlement Action Plan) will have to be made. It has to be considered, however, that resettlement of these villages is presently under way. It is not recommended to interrupt this process, since this would add to the degree of uncertainty, under which people in this area live and have been living already for a considerable period.

- In Stage 2, all villages below the elevation of 1290 m asl will have to be resettled. For this, a resettlement plan outline will be prepared, as a basis for a detailed RAP at a later stage (and under a different assignment).

The Stage 1 villages as well as the resettlement areas were visited, and an analysis of the situation has been prepared. The work done so far is described in the present report, however, analysis of the data is still under way and will be described in more detail in the ESIA.

As a consequence of the filling of Rogun reservoir, among other types of infrastructure the main road leading through the valley will be submerged. Therefore, a new road has to be built. There is a plan for such a road, and construction has started. This is described shortly in Chapter 14.

Chapter 15 describes the archaeological situation of the project area. A few findings of stone age sites confirms that the project area was inhabited already some 10'000 to 15'000 years before our area. Avesta (the holy book of Zoroastrianism), dating to 2'000 years BC, mentions a region called "Rankha" which is thought to correspond to the area where today Rogun is located. Graves from different periods have found in the project area, some form the Muslim period, others however considerably older. During several centuries the area had then a certain strategic importance, which is emphasised by the numerous fortresses which were built along the part of the silk road which led through the Vakhsh valley. These few facts highlight the long time period during which the area has been inhabited. However, as the field work has shown, most of these historical sites have been destroyed, some of them rather recently, by human activities. There is one site with probably rather intact fortresses which might be affected by the project, and this should be investigated before reservoir filling. The other important aspect of the area is the oral tradition of the local population, and this should be documented by an ethnographic study before resettlement is completed.

Chapter 16 deals with construction site management. This is an important aspect since construction is going on.

There are basically two issues to be considered. One is the aspect of erosion control and site rehabilitation after finalisation of the works. A number of problems in this respect were identified, and measures on how to deal with this situation will be proposed in the ESIA report.

The second issue is Environment, Health and Safety (EHS) management on site. Previous visits and a preliminary audit confirmed a number of rather serious problems in this respect, like waste management on site (including waste water from different sources), use of personal protection equipment (PPE), workplace conditions, risk of accidents, etc. In the ESIA report, an outline of an EHS management plan will be proposed, which the Consultant feels is an urgent requirement for the site.

Transboundary issues are addressed in Chapter 17. Here, based on a number of documents which had been handed over to the Consultant, the position of Uzbekistan is described. In addition, it is outlined shortly in which way the Consultant intends to address this very relevant and sensitive topic. A key element for this will be the results of the hydraulic model mentioned above.

An additional point to be discussed in the further development of the study is the coordination with other studies. On the one hand, there is the requirement of coordination with TEAS, which needs to be improved. On the other hand, The TOR for the ESIA require a coordination with, and mainly a use of the results of, an SEA to be conducted under a separate WB assignment, in parallel with the ESIA. So far, there still is no such study. This situation needs clarification.

The work carried out so far has shown clearly that not all of the topics covered by the ESIA are of the same importance. Shortly, the following main conclusions have been reached:

- **Climate:** climatic conditions as such are not of concern for the study; the reservoir will be too small for actually influencing the climate even on a local scale. However, the issue of climate change might be of more importance. It remains to be decided (by BT and WB) to what extent this issue should be investigated.
- **Hydrology:** the importance of this subject is quite obvious, since the Project has the potential to influence the conditions in the downstream area in a considerable way. Given the needs for water downstream of Nurek dam (for irrigation, drinking water, the persistence of the special ecosystem in the Tigrovaya Balka Nature Reserve, and including the operation of Nurek HPP itself), but especially given the implications for the riparian countries, it is obvious that this aspect needs to be analysed carefully. This will also require an interaction with the TEAS Consultant (e.g. modelling of Rogun filling phase and operation).
- **Geology:** important aspect mainly with relation to slope stability, erosion risk, reservoir sedimentation, and dam safety. Exchange with the TEAS Consultant needs to be intensified.
- **Biodiversity:** the analyses carried out so far have shown, that the project area does not contain any biota of exceptional value. This is largely related to the quite intensive human use of the area. The vegetation in general is of a type which is widespread in Tajikistan (and beyond), and shows signs of partially severe degradation, not in the least due to overgrazing and the lack of proper pasture management. This has effects on the fauna, which can also be considered as affected by human interference. No species (neither of plants or animals) will be in danger of becoming seriously reduced or even extinct due to the Project. The fish fauna is impoverished; this is certainly in part due to Nurek dam, and the fact that a number of exotic species were introduced into the area in an attempt to develop fisheries in the reservoir might have contributed to this. The only potentially significant impact which Rogun HPP might have is the one on Tigrovaya Balka, by further influencing the hydrological conditions in this floodplain area which depends entirely on river dynamics; this emphasises the importance of hydrological considerations in this project.
- **Resettlement:** this is undoubtedly, along with hydrology, the second of the two most important issues to be dealt with in the framework of this Project. An important number of people need to b relocated, and as the analysis so far has shown the situation is made more complex and more difficult to understand by the fact that resettlement has started almost 30 years ago, was then interrupted by the political and social consequences of the breakdown of the Soviet Union and the independence of Tajikistan, and is presently under way.
- **Archaeology:** while the analysis has shown that the project area has been inhabited since the stone age and later on had a certain importance due to its

location on the silk road, it has also revealed the fact that most historical sites and artefacts in the area have been destroyed by human activities. Two aspects remain which should be investigated as part of the compensation measures, namely (i) one site of still at least partly intact fortresses which might be affected by the reservoir, and (ii) the local ethnography, which otherwise will be lost due to the relocation of the population.

- **Environment, Health and Safety:** this is a subject of importance for the construction period (which, at least to some extent, is going on right now). A number of issues have been identified during the preliminary investigation, and a framework for a comprehensive EHS management on site will be developed in the ESIA.
- **Site restoration:** this is an aspect of importance for every large construction site. In the case of Rogun HPP, however, it is strongly related to the geological conditions, and mainly to the risks of erosion and landslides. Measures will be proposed for reducing these risks.

1 INTRODUCTION

This is the Initial Environmental and Social Screening (IESS) Report of the ESIA for Rogun HPP.

In general terms, the IESS serves the following main aims:

- To reach, by means of checking available information, short site visits and preliminary discussions with key stakeholders, a first appreciation of the prevailing situation in the project area.
- To identify the issues which will be (or might be) affected in any meaningful way by the project. If at this stage it already becomes clear that a certain aspect will not be affected by the project, then it will be eliminated from further work for the preparation of the ESIA Report.
- To see what information is already available on the relevant issues, and what kind of information will still have to be obtained (e.g. by specific field work) in the next steps.
- To prepare a work plan for the next steps.

For the case of Rogun HPP EISA, the TOR specifically mention the following points:

- The environmental screening has to include a (preliminary) audit of the construction site and the work already done. This will then have to show if a more detailed audit will have to be carried out at a later stage.
- For the social screening, the following aspects have to be taken into consideration:
    - Contacts to local authorities (leaders of affected communities) in order to get an impression on past and ongoing resettlement efforts.
    - Site visit of an archaeologist in order to identify if any objects or sites of archaeological, historical or cultural interest are (or are suspected do be) present in the area, which might have to be investigated in more detail during the following stages of Project development.
    - Audit of social issues focussing on past resettlement.
    - "The specific social tasks listed in Annex 4 of the TOR will all be checked for their relevance in the framework of the project, and commented upon in the IESS. However, if detailed field work is required for any of them, it will have to be decided to what extent this can be done during the initial screening process, and what will have to be done as part of the ESIA."

2 LEGAL AND ADMINISTRATIVE FRAMEWORK

2.1 Environmental Protection

Annex 2.1 provides a list of the relevant laws on protection of the environment.

The ESIA 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. Its Appendix 1 defines the projects for which an EIA is required, and point No. 1 in this list is “Hydropower, thermal power plant and other facilities with thermal output of 300 Megawatt”. Rogun HPP, with an installed capacity of 3’600 MW, is undoubtedly such a project.

Appendix 4 of the Procedure provides a flow chart of EIA procedure (see Figure 2-1 on the following page).

2.2 Resettlement

Resettlement in Tajikistan in general, and Rogun HPP specifically, is guided by two texts, namely:

- **Regulations on Domestic Migration Procedure in the Republic of Tajikistan**

  (Resolution No. 467 of Oct. 1, 2008; see Annex 13.4.2).

- **Resettlement of the Population of Rogun Town and Nurobod Rayon from Zones of Submersion of Rogun Hydropower Plan**

  Resolution No. 47 of January 20, 2009: see Annex 13.4.1).

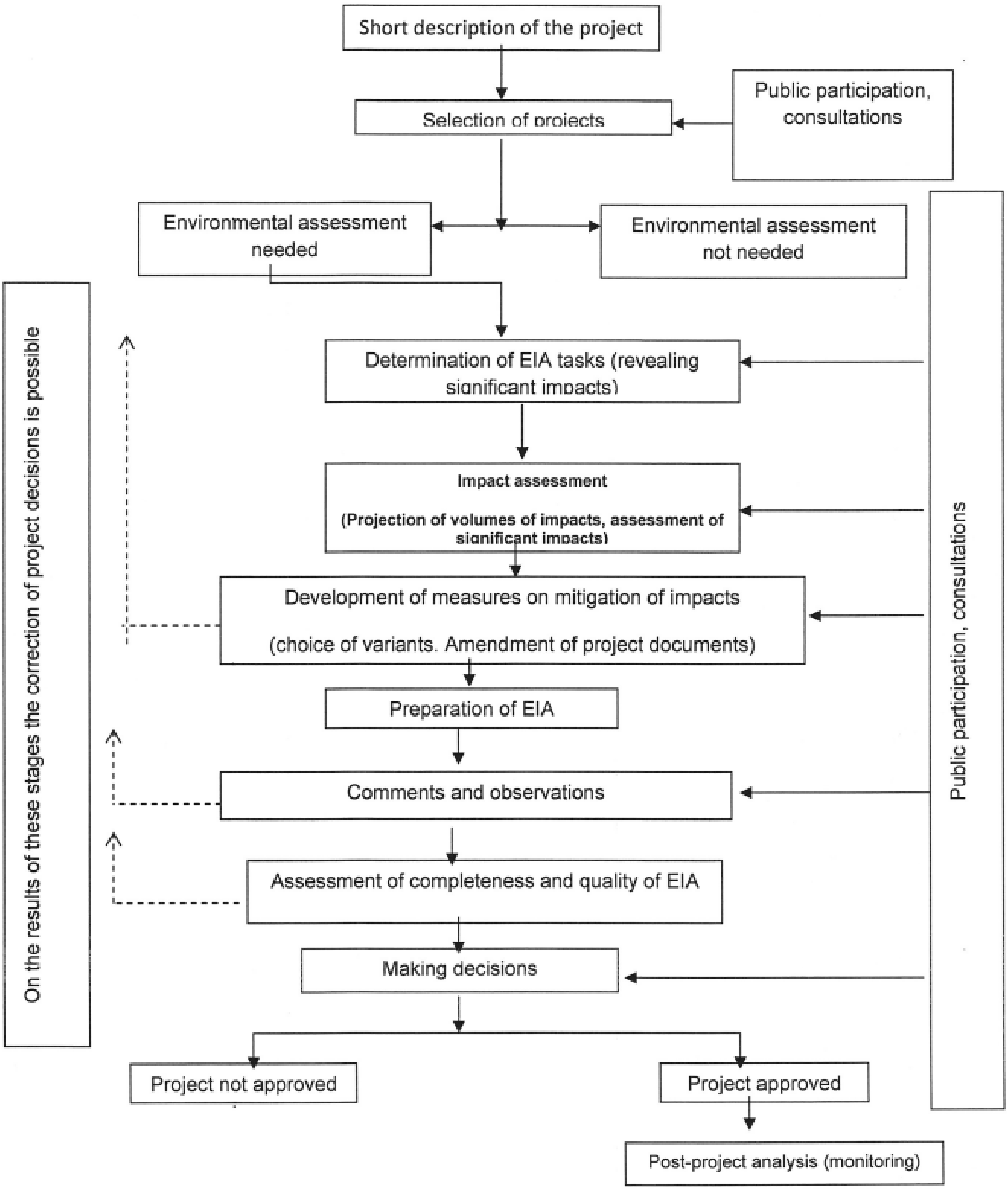

Figure 2-1: EIA procedure

2.3 International Standards

The main applicable international standards for the Rogun HPP ESIA are the Operational Policies (OPs) of the World Bank (WB). The following Table lists these standards and comments on whether or not they are applicable in the present case.

Table 2-1: Applicable World Bank Operational Policies (OPs)

OP No.	Title	Dated	Comments
4.01	Environmental Assessment	Jan. 1999	Applicable. The project is clearly of a type and size (Category A Project) which requires a full environmental assessment.
4.04	Natural Habitats	Jun. 2001	Applicable. Some natural habitats are affected directly (by submersion at filling of reservoir) and indirectly (by change in river discharge conditions).
4.09	Pest Management	Dec. 1998	Not applicable.
4.10	Indigenous Peoples	Jan. 2005	Not applicable. The population of the project area is not considered - and does not understand itself - as an ethnic minority.
4.11	Physical Cultural Resources	Jan. 2006	Applicable. A number of cultural (historical, archaeological) sites are known to exist in the project area.
4.12	Involuntary Resettlement	Dec. 2001	Applicable. A total of 63 villages with a total of approximately 30’000 inhabitants have to be resettled due to the project.
4.36	Forests	Nov. 2002	Applicable. Some forest areas are affected by the project.
4.37	Safety of Dams	Oct. 2001	Applicable. It is a project of a high dam in a seismic active area. Dam safety must have a high priority in this project (aspect to be covered mainly in the technical assessment and design).
7.50	Projects on International Waterways	June 2001	Applicable. The river to be used for the project, Vakhsh, is a main tributary of Amu Darya, whose water is essential for irrigation and water supply in riparian countries (mainly Uzbekistan and Turkmenistan). Amu Darya is one of the two tributaries of Aral Sea.

3 THE PROJECT

3.1 Project Location

Rogun Hydropower project is located on the Vakhsh river about 70 km upstream of the Nurek Dam and in a distance of approximately 110 km east of the capital, Dushanbe. One of the tributaries of Vakhs river, the Kizil-Su, originates in Kyrgyzstan, flows through the Pamir Altai Mountains o fTajikistan and joins the Muk-Su, forming the Surkhob river. Vakhs river is formed by the confluence of Surkhob with the Obihingou; it then joins the Pyanj river to form the Amu Darya (Darya meaning river); Pyanj and Amu Darya form the border of Tajikistan with Afghanistan. The drainage area of the Vakhsh River in Tajikistan is 31’200 km^2. Most of the river runs through very mountainous territory. At the dam site, about 340 km upstream of the confluence with the Pyanj river, the river flows through a narrow, 400-500 m deep V-shaped gorge with gradients of the valley sides up to 50°.

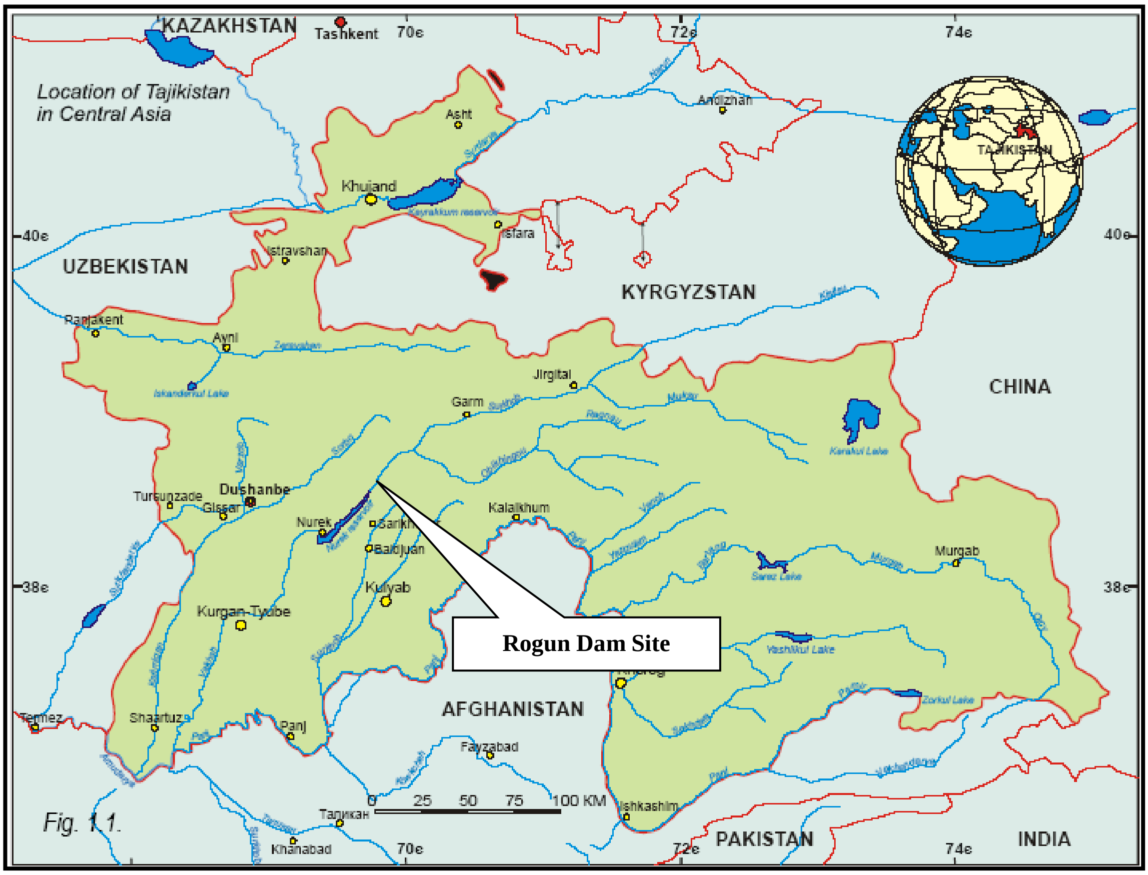

Figure 3-1: Map of Tajikistan indicating Rogun dam site

Rogun dam site (38°40’34 N; 69°46’23 E) is located in the Rasht region, which is divided in seven districts (rayons), namely, Fayzabad, Rogun, Nurobod, Rasht, Tavildara, Tojikobod and Jirgital. The Construction site and the future reservoir will directly affect Rogun, Nurobod, and Rasht (See Figure below).

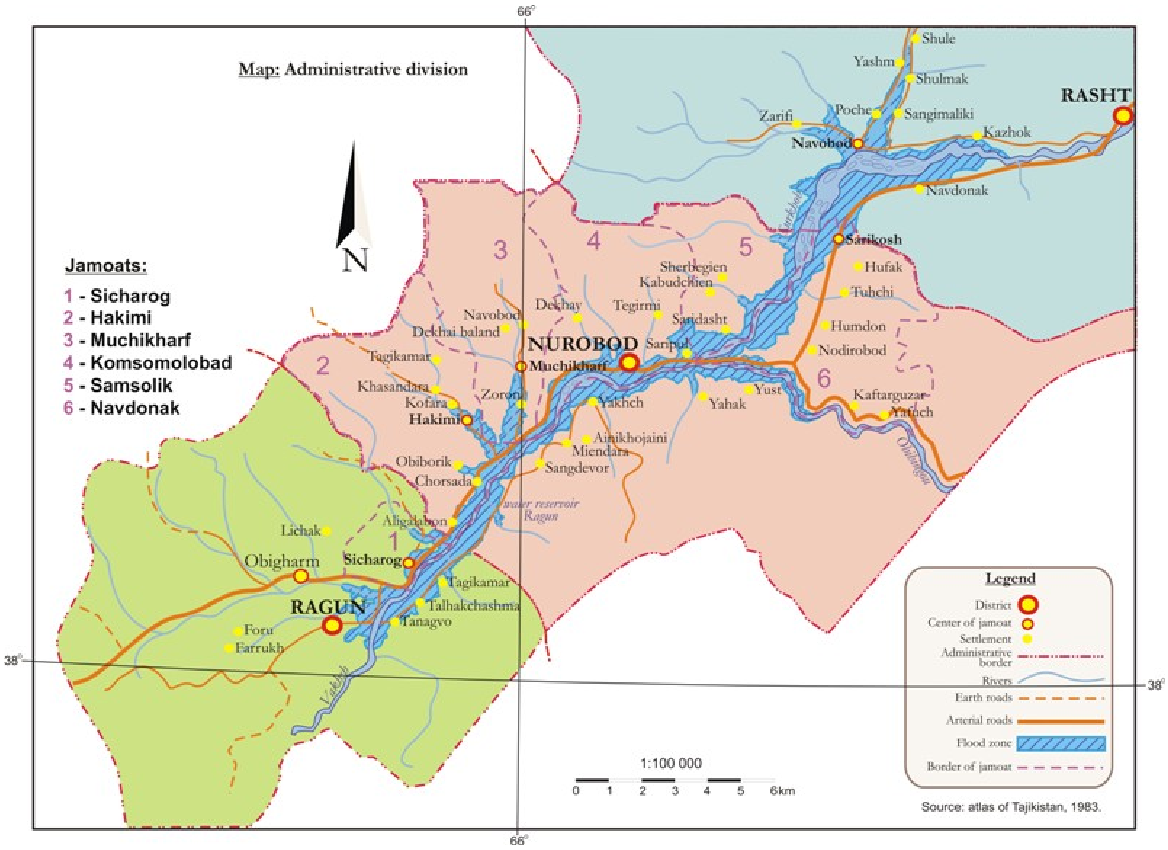

Figure 3-2: Outline of Rogun reservoir with affected districts

3.2 Rogun HPP

Here, a preliminary short description of the Project is provided; this will be updated as required during the development of the study. It should be noted that all the information on the Project provided here is derived from existing documents and needs to be checked - and adapted if required - with TEAS.

The following Table provides the essential key figures on the Project.

Table 3-1: Main parameters of Rogun HPP

Parameter / Параметр	Unit	Единица	Stage 1	Stage 2
1. Dam / Плотина				
Type / Тип				
Height / Высота	m	м	160	335
Crest length / Длина по гребню	m	м		620
Crest elevation / Отметка гребня	m asl	м н.у. м.[a]	1'120[c]	1'300
Riverbed elevation / Высота русла реки	m asl	м н.у. м.[a]		
Volume / Высота русла реки	10^6 m³	10^6м^3		
2. Reservoir / Водохранилище				
Full supply level (FSL) / Площадь резервуара при ПУВ	m asl	м н.у. м.[a]	1'110[c]	1'290
Area at FSL / Участок в ПУВ	km²	км^2		170
Total volume at FSL / Общий объем в ПУВ	10^6 m³	10^6м^3	>250	13'300
Live volume / Полезный объем	10^6 m³	10^6м^3		8'600
Minimum operation level (MOL) / Минимальный эксплуатационный уровень (МЭУ)	m asl	м н.у. м.[a]	1'110	1'185
Area at MOL / Площадь при Минимальном эксплуатационном уровне	km²	км^2		50.6
3. Power house and capacity / Электростанция и мощность				
Powerhouse type / Тип электростанции (подземный, надземный)			Underground / надземный	Underground / надземный
Total installed capacity (tentative) / Общая установленная мощность (предполагаемый)	MW	МВт	240 (2x600)[b]	3'600 (6x600
Turbine type / Тип турбины				
Number of units / Количество турбин	N	ШТ	2	6
Capacity of turbines / Мощность турбины	MW	МВт	2	
Turbine output / Расход воды в турбине	m³/s	м^3/с		6x274
Total head / Номинальный напор	m	м	80	245
4. Waterways / Характеристики турбины				
Water intake level / Уровень водозаборного сооружения	m asl	м н.у. м.[a]	1035	1152 – 1172
Headrace tunnel (N, length) / Подводящий туннель (Н / длина)	N / m	Н / м	448	514
Penstock length / Длина напорного трубопровода	m	м		
Tailrace tunnel length / Длина водоотводящего туннеля	m	м		2x850
5. Hydrology / Гидрология				
Catchment area / Район охвата	km²	км^2		30'390
Average river discharge at dam site / Средняя величина речного расхода на участке плотины	m³/s	м^3/с	631	631
Annual rainfall / Годовые дождевые осадки	mm	мм		700-838
Potential annual evapo-transpiration / Потенциальное годовое суммарное испарение (эвапотранспирация)	mm	мм		806
6. Transmission lines / Линия передачи				
Nominal voltage / Номинальное напряжение	kV	кВ	500	
Length / Длина	km	км		
Nominal voltage / Номинальное напряжение	kV	кВ	500	
Length / Длина	km	км		
7. Access Roads / Подъездные дороги				
Construction (new road) / Строительство (новая дорога)	km	км	-	-
Improvement of existing road / Улучшение существующей дороги	km	км	11	11

[a] м над уровнем моря
[b] due to low head capacity limited to 120 MW
[c] the definition of Stage 1 was changed, from a reservoir with FSL of 1055 m asl to 1110 m asl (see Section 3.6).

3.3 Short Project History

Rogun HPP started in mid-1960's based on the following economic objectives:

- water storage capacity for irrigation projects at the Amu-Darya in Uzbekistan and Turkmenistan;
- power supply for Tajik Aluminium Smelter (TadAZ) and the South Tajikistan industrial complex;
- increasing the total power output of the downstream Golovnaya, Baipaza, Sangtuda and Nurek Hydropower Plants by some 1.1 TWh;
- producing cheap electricity for the former Soviet Central Asian economy;
- for peak load in the Central Asia grid;
- decreasing the need for thermal power generation in Central Asia.

Up to 1978 the detailed design for a 335 m high embankment dam and 6 x 600 MW generating units to be installed in an underground powerhouse was prepared; preparatory works started already in 1976. The final approval for Rogun HPP was given in 1980 and main construction started in 1982.

Main parts of the underground works and a 45 m high cofferdam were constructed until 1990 when the work came to hold due to political changes and the independence of Tajikistan. In 1993 a flood occurred, during which the diversion tunnels were clogged and the cofferdam was overtopped and destroyed. Further damage was caused by an earthquake in 1995.

3.4 The Reference Project for the ESIA

There are three main project studies, the original one of 1978, the Lahmeyer study of 2006, and the Hydroproject Study of 2009.

The basis for the ESIA, as it is now, is the original design of 1978, with the updates of the 2009 study. This latter study did not change the project as such, nor the arrangements of the main parts (taking into account that most of the underground structures are built already), but it adapted the project for it to be in compliance with new norms. This mainly concerns flood discharge; the original project was dimensioned for a probable maximum flood (PMF) of 5’400 m^3/s, and this, according to new standards, was increased to a PMF of 7’100 m^3/s (Mr. Shamshulloev, Rogun HPP, pers. comm. 2011-04-13).

The Lahmeyer study, according to the same source, had a different objective, namely, to modify the project in a way as to be built faster, and covering the electricity needs of an aluminium smelter which RUSAL intended to build. However, it did not take into account the energy requirements of the country and therefore was not accepted by GOT.

3.5 The Vakhsh Cascade

Rogun HPP is the uppermost of a planned - and partly built - cascade on the Vakhsh river. Five of the plants are already operating, Rogun HPP and Sangtuda-1&2 HPP are under construction, and Shurop is under planning (see following Figure).

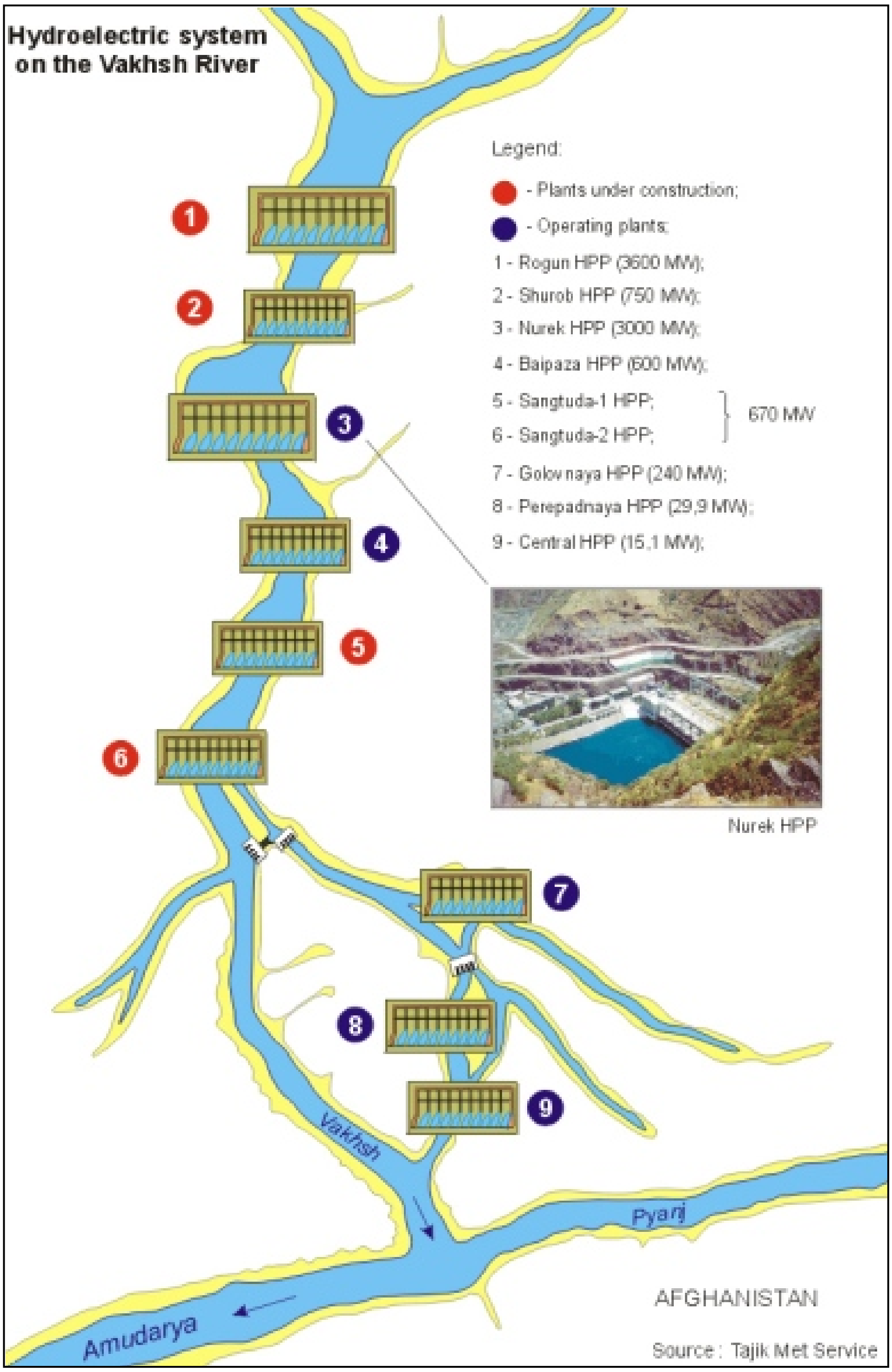

Figure 3-3: Hydropower cascade on Vakhsh River

The ESIA will have to take into account the fact that Nurek dam, a high dam with a large reservoir, is in operation since about 30 years, and that it also provides water for irrigation in its downstream area. The other existing hydropower projects (which have also to be considered) have a rather small storage, with limited effect on river discharge.

3.6 New Definition of Stage 1

The TOR for the Rogun ESIA defined two Stages as follows:

- Stage I: dam crest level at 1060 m asl, reservoir full supply level at 1055 m asl.
- Stage II: dam crest level at 1300 m asl, reservoir FSL at 1290 m asl.

According to the TOR, for Stage I a full RAP needs to be prepared, while for Stage II a RAP outline/framework will have to be prepared.

In the initial phase of the assignment, however, it became apparent that the definition of the Stage I as given above needed to be revised, and adapted to the conditions of the Project. As a matter of fact, as Figure 18-1 in Annex 3 shows, the FSL of 1055 m asl only marks the point in time when the first units will start operation, but it will not be a situation that will be maintained for any length of time. Reservoir level will continue to rise until it reaches 1110 m, and at this level it will probably remain for a number of years, while construction of the dam continues. For this reason, Stage I needs to be redefined to include a reservoir with FSL of 1110 m asl.

The relevant practical difference of this change lies in the fact that at that reservoir level one village, Chorsada, located at an altitude of about 1100 m asl, will have to be relocated, and that therefore the RAP will have to include this village.

The Consultant has addressed to the Client a letter with a request for a change in contract for this supplementary work, dated May 23, 2011. At the moment when this Report is being written, the Consultant still awaits a reaction of the Client to this letter.

The discussions held in August 2012, and especially the presentations made by TEAS, revealed that Stage I, mainly due to the extraordinarily high sediment load carried by Vakhsh river, will not be feasible as a stand-alone project which could be operated as such over a longer period. For this reason it was decided that no Stage I ESIA Report will be prepared as stand-alone document, However, a Stage I RAP will still be prepared.

4 THE STUDY AREA

4.1 The Amu Darya Basin

The study area is located within the Amu Darya basin (see following Figure).

Figure 4-1: The Amu Darya basin

The red triangle indicates the location of Rogun dam
Source: www.cawater-info.net/**amudarya**/geo_e.htm

The Amu Darya is the largest river in Central Asia. Its length from the origin of Pyanj river is 2'540 km, the catchment area is 543'739 km². It is called the Amu Darya downstream of the point where Pyanj and Vakhsh rivers meet. Four large right bank tributaries (Kafirnigan, Surhan, Sherabad and and Zeravshan) and one left bank tributary (Kunduz) flow into the Amu Darya within its middle reach; today, the Zeravshan does not reach the Amu Darya any longer, since its wate is being used for irrigation within the territory or Uzbekistan. Further downstream towards the Aral Sea it has no more tributaries. It is fed largely by water from melted snow, thus maximum discharges are observed in summer and minimum ones in January-February.

4.2 Vakhsh River

4.2.1 The Origin of Vakhsh River

One of the river's sources, its tributary Kizil-Su, lies in a very remote area of southern Kyrgyzstan near the Chinese border, where it runs westwards for 262 km; it then flows through Tajikistan for a length of 524 km before joining the Pyanj River to form the Amu Darya at the border of Tajikistan and Afghanistan.

The Figure in the following page illustrates in diagrammatic from the river system in the wider study area.

As can be seen from this graph, the river gets the name “Vakhsh” at the confluence of Surkhob and Obihingou rivers; the former of these two is formed by the confluence of Muksu and Kizil-Su rivers; Kizil-Su, which is one of the spring rivers of Vakhsh, originates in Kyrgyzstan. Muksu river, which originates from Fedchenko glacier - the largest glacier of Central Asia - is the main source river of Vakhsh. Vakhsh runoff is approximately 20 km^3/year, to which Muksu contributes 3.53 km^3 and Kizil-Su 1.65 km^3.

Vakhsh river then flows in a generally south-western direction to the border with Afghanistan, where it meets Pyanj river. These two then from Amu Darya. Downstream of the Pyanj-Vakhsh confluence, only one more river o some importance joins the Amu Darya, the Kafirnigan.

4.2.2 Main Characteristics

For most of its route, Vakhsh rushes through alpine mountains, before slowing down in the plains of southern Tajikistan. The river, which is fed mostly by melting glaciers, achieves maximum flow during the summer months of July and August. The river flows through very mountainous territory, which frequently restricts the river's flow to narrow channels within deep gorges. The river's watershed area is 39’100 km^2, of which 31’200 km^2 lie within Tajikistan. The largest tributaries of the Vakhsh are the Muksu and the Obihingou. The Vakhsh officially begins at the confluence of the Obihingou and Surkhob Rivers.

In its upper parts, Vakhsh is a mountain stream with a rather marked gradient, flowing mostly through a rather narrow valley with steep slopes. On a considerable part of this mountain section it flows in a gorge-like valley deeply cut into lateral alluvions. Only on a few sections the valley is wider and almost flat, and here the river has formed extensive floodplains. Two of these, one near Komsomolobod, the other near Novobod, are located within the area of the future reservoir. Likewise, the confluence of Surkhob and Obihingou will also be submerged by the reservoir.

Downstream of Nurek, Vakhsh river flows through a gradually widening plain. In its lowest part, before the confluence with Pyanj, it flows in wide meanders in wide plain; this is the protected wetland area called Tigrovaya Balka.

	HPP	ГЭС
1	Rogun	Рогун
2	Shurob	Шуроб
3	Nurek	Нурек
4	Baipaza	Байпаза
5	Sangtuda 1	Сангтуда 1
6	Sangtuda 2	Сангтуда 2
7	Golovnaya	Головная
8	Perepadnaya	Перепадная
9	Central	Централ

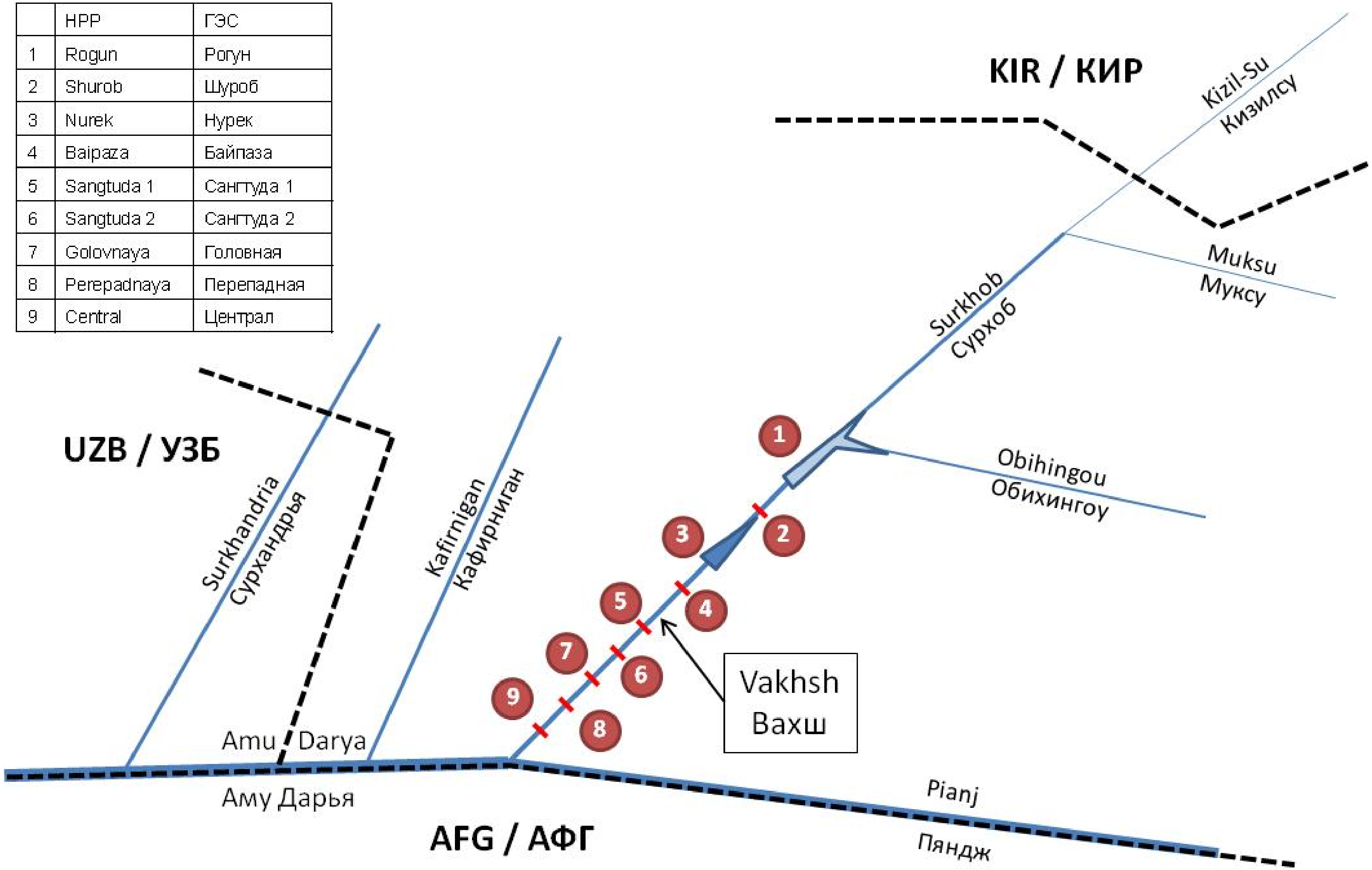

Figure 4-2: Diagrammatic view of river system in the study area

Black dotted lines: international borders. Graph not drawn to scale.

4.2.3 Vakhsh as an International River

4.2.3.1 Vakhsh River

As has been shown above, the rive with the name “Vakhsh” originates at the confluence of its two main tributaries, and it ends at the confluence with Pyanj river. In this sense, Vakhsh could be considered as an entirely Tajik river.

However, as was shown above an as the Figure below illustrates again, a part of its waters come from Kyrgyzstan, and Vakhsh a major tributary of the Amu Darya. Hydrologically, it is certainly a unit, in spite of the changes in name along its course.

Figure 4-3: Vakhsh river

Source: http://en.wikipedia.org/wiki/File:Vakhsh.JPG

In its publication on shared rivers, ICOLD (2007: 233), for the case of Central Asia, under the heading International Shared Rivers does not list individual rivers, but the entire Aral Sea basin as a unit, with the following parties and their respective share of the entire basin:

- Kazakhstan 424'739 km²
- Uzbekistan 382'286 km ²
- Turkmenistan 69'671 km²
- Kyrgyzstan 112'093 km²
- Tajikistan 135'942 km²
- China 1'583 km²
- Afghanistan 100'691 km²
- Pakistan 3'349 km²
- Aral Sea basin total 1'230'408 km²

4.2.3.2 Definition of International River

In its Operational Policy on International Waterways, the World Bank provides the following definition:

(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).

Source: WB OP 7.5, Projects on International Waterways, 2001

Vakhsh has to be considered as being an international river (alternative terms often used: shared or transboundary river) according to this definition.

4.2.3.3 Rules for the Use of International Rivers

According to ICOLD (2007:21), "When a river passes from one state (country, region) to another, the sharing is not on equal basis. In principle, every country has the right to use the water on the basis of international agreements and principles (...). The out-flowing water from a state should be of acceptable quality for subsequent downstream use."

There is no body of universally acknowledged and worldwide applicable international law on shared rivers (ICOLD 2007:31).

Several international conventions (UN Convention, Helsinki Rules of the International Law Association and revised SADC Protocol specify criteria for equitable and reasonable utilisation of transboundary rivers, such as:

- Natural factors as hydrology, climate
- Social and economic needs
- Population dependent on watercourse
- Effects on uses on other watercourse states

- Existing and potential uses
- Conservation, protection, development and economy of use and the costs of measures
- Availability of alternatives of comparable value.

Again according to ICOLD (2007:37), “Watercourse states are obliged not to cause significant harm to other co-basin States and should take all appropriate mitigation measures. Provision could be made for compensation in certain instances.”

“Best mechanism of sharing water is by application of Article 6 of the UN Convention on the Law of the Non-Navigational uses of international watercourses;” (ICOLD 2007:71). The text of this article is provided in the following Table (together with the official translation into Russian).

Table 4-1: Articles 5 and 6. UN Convention on International Waters

Article 5: Equitable and Reasonable Utilization and Participation
1. Watercourse States shall in their respective territories utilize an international watercourse in an equitable and reasonable manner. In particular, an international watercourse shall be used and developed by watercourse States with a view to attaining optimal and sustainable utilization thereof and benefits therefrom, taking into account the interests of the watercourse States concerned, consistent with adequate protection of the watercourse.
2. Watercourse States shall participate in the use, development and protection of an international watercourse in an equitable and reasonable manner. Such participation includes both the right to utilize the watercourse and the duty to cooperate in the protection and development thereof, as provided in the present Convention.
Article 6: Factors Relevant to Equitable and Reasonable Utilization
1. Utilization of an international watercourse in an equitable and reasonable manner within the meaning of article 5 requires taking into account all relevant factors and circumstances, including:
(a) Geographic, hydrographic, hydrological, climatic, ecological and other factors of a natural character;
(b) The social and economic needs of the watercourse States concerned;
(c) The population dependent on the watercourse in each watercourse State;
(d) The effects of the use or uses of the watercourses in one watercourse State on other watercourse States;
(e) Existing and potential uses of the watercourse;
(f) Conservation, protection, development and economy of use of the water resources of the watercourse and the costs of measures taken to that effect;
(g) The availability of alternatives, of comparable value, to a particular planned or existing use.
2. In the application of article 5 or paragraph 1 of this article, watercourse States

concerned shall, when the need arises, enter into consultations in a spirit of cooperation.

3. The weight to be given to each factor is to be determined by its importance in comparison with that of other relevant factors. In determining what is a reasonable and equitable use, all relevant factors are to be considered together and a conclusion reached on the basis of the whole.

Статья 5: Справедливое и разумное использование и участие

1. Государства водотока используют в пределах своей соответствующей территории международный водоток справедливым и разумным образом. В частности, международный водоток используется и осваивается государствами водотока с целью достижения его оптимального и устойчивого использования и получения связанных с этим выгод, с учетом интересов соответствующих государств водотока, при надлежащей защите водотока.

2. Государства водотока участвуют в использовании, освоении и защите международного водотока справедливым и разумным образом. Такое участие включает как право использовать водоток, так и обязанность сотрудничать в его защите и освоении, как это предусмотрено в настоящей Конвенции.

Статья 6: Факторы, относящиеся к справедливому и разумному использованию

1. Использование международного водотока справедливым и разумным образом по смыслу статьи 5 требует учета всех соответствующих факторов и обстоятельств, включая:

a) географические, гидрографические, гидрологические, климатические, экологические и другие факторы природного характера;

b) социально-экономические потребности соответствующих государств водотока;

c) зависимость населения от водотока в каждом государстве водотока;

d) воздействие одного или нескольких видов использования водотока в одном государстве водотока на другие государства водотока;

e) существующие и потенциальные виды использования водотока;

f) сохранение, защиту, освоение и экономичность использования водных ресурсов водотока и затраты на принятие мер в этих целях;

g) наличие альтернатив данному запланированному или существующему виду использования, имеющих сопоставимую ценность.

2. При применении статьи 5 или пункта 1 настоящей статьи соответствующие государства водотока, в случае возникновения необходимости, вступают в консультации в духе сотрудничества.

3. Значение, которое должно быть придано каждому фактору, подлежит определению в зависимости от его важности по сравнению с другими соответствующими факторами. При определении того, что является разумным и справедливым использованием, все соответствующие факторы должны

рассматриваться совместно и заключение должно выноситься на основе всех факторов.

Source:
UN Convention on the Law of the Non-navigational Uses of International Watercourses
КОНВЕНЦИЯ О ПРАВЕ НЕСУДОХОДНЫХ ВИДОВ ИСПОЛЬЗОВАНИЯ МЕЖДУНАРОДНЫХ ВОДОТОКОВ
http://internationalwaterlaw.org/documents/intldocs/watercourse_conv.html

4.3 Subdivisions of the Study Area

For the purpose of this ESIA, the study area has to be divided into several specific areas, which not all need the same level of detail in the study. In general, the following are the main parts:

- Dam and powerhouse site and surroundings, which in this case can be subdivided into the following two categories:
  - The existing construction area of Rogun HPP: the construction has already started in the early 1980s and couldn’t be developed further due to the civil war in 1992. This area will have to be assessed in detail, since the new construction site has to be included, damaged structures will have to be demolished, actions against erosion will have to be taken and waste will have to be disposed of properly, etc.. An additional point will be health and safety for the old construction site.
  - The new construction area which has to be integrated into the old one, mainly dam and power house site, appurtenant structures and immediate surroundings (construction sites, construction camps, quarries, borrow and disposal areas, etc.): this is where most of the construction activities take place, and where a large amount of the environmental impacts happen. This area has to be considered with much detail, especially for the construction phase. Furthermore, it will be affected in a relevant and permanent way by the Project, This will be a high intensity area for field investigations.
- Reservoir area: the future reservoir, i.e. the area which will be covered by water (approximately 170 km^2), is also an area in which the effects of the Project will be very apparent and which therefore needs to be considered in detail (especially the resettlement of 63 villages).
- Immediate reservoir catchment: this is the area directly surrounding the reservoir, which can be influenced by the project in different ways (e.g. change in groundwater regime, triggering of landsides, increasing pressure on habitats, etc.).
- Downstream area during the construction phase:. The main effect on the downstream area is the risk of water pollution and its potential impacts on water users in this area. This includes the risk of an increase in sediment load due to construction activities, which is potentially quite considerable.
- Downstream area during operation phase: Starts below the powerhouse outlet, where the river discharge pattern will be influenced by turbine operation. The impact can be small in the case of run-of-river schemes (Stage 1), and

potentially very important in the case of storage schemes with intermittent (e.g. peaking) power production (Stage 2), which can cause seasonal changes in river discharge pattern and important short term fluctuations. The extent of the area to be taken into account depends on the specific situation. Potential issues are flow conditions as influenced by the project, cumulative impacts with existing power plants, water quality issues, effects on floodplain habitats, and effects on d/s water users. For Rogun HPP the downstream area can be divided into three main parts:

    - Between Rogun HPP and the upper end of Nurek reservoir, river discharge will be influenced very strongly by the operation of Rogun power plant; discharge will be very high during peaking production and can be reduced, in an extreme case to zero. when the turbines are shut down.
    - Below Nurek HPP until the confluence with Pyanj River (forming the Amu Darya), cumulative impacts of the hydropower cascade, provision of water for irrigation, and effects on floodplain habitats.
    - Amu Darya until the Aral Sea: in the case of international rivers (as is the case for Vakhsh River, an important tributary of Amu Darya), this includes effects on riparian countries. For this purpose, it will mainly be important to assess the amount of water flowing across the border, as well as its seasonal distribution, in order to verify whether Rogun HPP will cause any changes in this, during the filling and the operation phase.

  - Catchment area: the catchment or watershed area of Rogun HPP will not be affected by the Project as such, but the situation in this area can greatly influence the reservoir. The most important of these effects are eutrophication and pollution of the reservoir water by input of nutrients (stemming mainly from agriculture and human settlements) and siltation of the reservoir (due to erosion in the catchment, which again is often caused or at least considerably exacerbated by human activities).
  - River basin: for some effects, other developments in the same river basin have to be taken into account, since they can increase or reduce environmental (or social) effects of the project in question. However, it has to be pointed out that this is an ESIA for a specific project and not a CIA of all the projects in the Amu Darya basin, nor a SEA for the entire development plan of this river basin.

- Access roads: access roads can have major direct or indirect environmental impacts and will therefore have to be addressed. However, the project does not require the construction of any new access roads. Work for upgrading the existing road to Rogun from the main road near Obigarm is presently under way.
- Other areas, as might be relevant. This can comprise, e.g., transmission line corridors, resettlement areas, or areas to be occupied for the necessary relocation of infrastructure (e.g. existing roads which will be submerged).

5 THE ENVIRONMENT: GENERAL CONSIDERATIONS

5.1 Main Environmental Impacts of Hydropower Projects

The major direct and indirect impacts of any hydropower project are always the same; their relative importance, of course, will be determined by the site- and project-specific conditions. These main impacts are listed as follows (from Zwahlen 2003):

1. Interruption of a river continuum. The fact that a dam is built across a river will always interrupt a system that was, up to now, an entity. Direct consequences of this interruption are a change in river flow patterns, a change in sediment transport (mainly due to sediment retention in the reservoir), an interruption of fish migration (complete for upstream migration, obstacle and risk for downstream migration), and the interruption of drift (i.e., the more or less passive movement of various organisms downriver).
2. Change in river discharge pattern downstream of the dam. This effect is closely related to the first one. In this respect, two main parts of the river can be identified: (1) between the dam and powerhouse outlet, where discharge is reduced, in extreme cases to zero, and (2) downstream from the power house outlet, where river discharge is influenced by plant operation.
3. Change from river to lake conditions in a part of the former river at the formation of the reservoir. Water quality will change due to this effect, and the new lake is a habitat very different from that of the former river.
4. Destruction of terrestrial habitats. All terrestrial habitats within the reservoir area will be permanently destroyed, because they are going to be covered with water. This has effects on vegetation and fauna, as well as on the human population living in this area.
5. Access to the area provided by new access roads. Although the direct impact of the roads (e.g., on vegetation) might be rather small, the roads can trigger a development, especially in cases when hitherto inaccessible areas are opened in this way, that can have very considerable environmental effects.
6. Social impacts. These can be manifold. The most important in many cases is the involuntary resettlement as a consequence of a dam project, but there are also other socioeconomic effects, such as effects on the population in the downstream area (through disruption of river floodplain dynamics, groundwater table changes, etc.); immigration into the area, especially during the construction phase, as a consequence of job opportunities; and effects on the host population for the resettlers. A hydropower project has also positive effects on the local community, like providing jobs and therefore income (although often limited to the construction phase), improved access through better roads, improved infrastructure, rural electrification etc. These positive items have to be evaluated, planned and implemented carefully in order to have the expected effect.

Most other impacts that may arise are likely to be related to these major effects, very often as secondary consequences.

5.2 The Case of Rogun HPP

In a first general appraisal, concerning the list of main types of impacts given above, the following can be said for the specific case of Rogun HPP:

1. Interruption of a river continuum. This is certainly the case for Rogun HPP. However, it has to be taken into consideration that there is already a high dam, Nurek, a rather short stretch downstream of Rogun site. This means that any fish migrations that might have taken place before have already been interrupted. Rogun reservoir will also serve as a trap for sediments, and in this way it will increase the useful life span of Nurek reservoir.
2. Change in river discharge pattern downstream of the dam. Here again, the fact that there is already a high dam and a large reservoir on this river has to be considered. The discharge pattern of the river in its lower section is and will continue to be determined by Nurek. However, Rogun will add substantially to the regulating capacity through its storage volume. This means that with Rogun the potential to shift water from the high flow (summer) to the low flow (winter) period will increase. Since this is also a point of importance for the riparian countries, this will have to be analysed in detail.
3. Change from river to lake conditions in a part of the former river at the formation of the reservoir. Clearly a point to be taken into consideration in the ESIA.
4. Destruction of terrestrial habitats. The reservoir will cover an area of about 170 km^2. The type and importance of submerged habitats will have to be analysed.
5. Access to the area provided by new access roads. In the case of Nurek, no new access road needs to be built, since access is provided by existing roads.
6. Social impacts. The main social impact is the fact that a number of about 63 villages, with a total population of around 30’000, have to be resettled. This has to be analysed and planned carefully, and this included effects in the resettlements sites (including improvement of infrastructure in these sites). The effect of the construction phase (job creation on the local, regional and national scale; influx of population from outside) also has to be considered.

While in this sense Rogun can be considered as a “normal” hydropower project producing the effects generally associated with such projects, it still presents a condition that makes it different from most other such projects for which an ESIA has to be done, namely, the fact that construction - and resettlement - started a rather long time ago, and that some construction work is presently under way. This mainly means that for Environment, Health and Safety (EHS) issues related to the construction phase it is not sufficient to prepare a draft EHS plan as part of the ESMP. The present conditions on the construction site need to be taken into consideration, and proposals for improvement need to be made, if required. Likewise, it is not possible to plan resettlement in the “usual” way, since the plan needs to take into account and to be integrated into an ongoing process, and resettlement already carried out needs to be audited.

6 GEOLOGY AND SOILS

6.1 Theoretical Considerations

The geological conditions of the project site are decisive for the design and layout of a dam and hydropower project, and for this reason, geology has to be investigated a part of the technical studies for the project. However, the geology as such will not be influenced by the project. Nevertheless, there are three points which need to be considered, namely:

- Slope stability under the changed conditions, i.e. the presence of a reservoir; the water body as such, and especially the seasonal drawdown of the reservoir, can influence slope stability, especially if such slopes consist of loose material, and can therefore lead to landslides.
- Seismicity: the dam will have to be designed and built in a way as to resist seismic activity of the site; this is obviously a task for the technical studies. The risk for the areas downstream of the dam will have to be assessed.
- Reservoir induced seismicity: the presence of the reservoir, i.e. the weight of the stored water, can influence the local seismic activity.

All these points need to be dealt with in close cooperation with the technical project.

6.2 Scope

The main impacts of the Project, and mainly due to the reservoir of Rogun HPP, on the geological situation of the area can be divided in the following few subjects:

- activation of the potentially unstable slopes or sections of slopes during reservoir filling, and, as a result, increase the reservoir sedimentation;
- the seasonal reservoir level oscillation (drawdown) activates again and again the slopes, increasing instability and erosion processes, especially during first 5 – 10 years of operation;
- effects of the reservoir on the salt stock and potential resulting risks for the dam;
- since the reservoir is located along the most seismically active Vakhsh fault zone, reservoir triggered seismicity is of concern, since this will intensify the seismic activity of this area;
- activation of the seismicity increase the slopes failure processes in turn.

6.3 Available Information

The review of the existing documents of the Rogun Project that were provided by the Client allows to make a preliminary analysis of the project area in terms of geology and project impacts on the geological situation.

The most important of the reviewed documents were the volume 1174-T15 “Rogun HPP on the Vakhsh River. Engineering design. Part 1- Natural environment. Volume 3- Engineering-geological conditions” (1174-T15 «Рогунская ГЭС на реке Вахш. Технический проект. Часть 1 — Природные условия. Том 3 — Инженерно-геологические условия»), the report “Hydroproject Study of 2009” (Рогунская ГЭС на реке Вахш в Республике Таджикистан. Концепция достройки станции. Гидропроект-Москва, 2009): the document # 1861-2-II-3 “Volume II - Engineering-geological conditions, Book 3 – Engineering-geological conditions (№ 1861-2-II-3 «Том 2 Природные условия. Книга 3 -Инженерно-геологические условия»), the document #1861-2-VIII “Volume VIII – The procedures for reservoir area preparation (№1861-2-VIII “Том VIII Мероприятия по подготовке зоны водохранилища). These documents are accompanied by a large number of drawings, layouts, cross-sections, tables, and provide sufficient information about general geology of the project area, especially about the dam site, including stratigraphy, lithology, faults systems and seismicity of the area, many cross-sections of the dam site location, rock jointing just on the HPP site (dam and tunnels), quarries location and rocks conditions, the reservoir area and slopes instability around it, tributaries with a high sediment load and so on.

The majority of the given information concern the technical aspects of the HPP design. Below the description and preliminary analysis of the information pertaining to the environmental assessment is given.

6.4 Specific Issues

6.4.1 Slope Failures and Erosion

The original report of 1978 (volume 1174-T15 “Rogun HPP on the Vakhsh River. Engineering design. Part 1- Natural environment. Volume 3-Engineering-geological conditions” (1174-T15 «Рогунская ГЭС на реке Вахш. Технический проект. Часть 1 — Природные условия. Том 3 — Инженерно-геологические условия») describes the general situation concerning the slope failures and erosion processes. The majority of the landslides are located just near the dam site in the Obi-Garm river valley, Obi-Chushon valley, and Passimuraho valley. Small rock slides (not active now, so called “ancient rock slides”) were detected just at the dam site on the left and right sides of the Vakhsh River (with volumes from 1000 to 1 million m^3). The biggest rock slide mentioned also in report is located just downstream of the dam site. The assessed volume of this rock slide is up to 900 million m^3, but its activity is not sufficiently clarified.

Exposure of the reservoir to landslides is mostly from its left bank, but the volume identified for such single events amounts to not more than a few million m^3. The biggest problem for the dam site is the high bed load of the Obi-Shur river, a left bank tributary of Vakhsh just downstream of the dam. The soils most prone to erosion are located on the left side of the Vakhsh River as well, represented by Quarternary deposits like diluvium, proluvium and alluvium. All these deposits have a high content of sandy loam with a clay fraction and carbonate cement, and this is a basis for a very active erosion processes.

Concerning the influence of the future reservoir on the slope failure processes the original report of 1978 comes to the conclusion that the reservoir will not lead to big landslides along its shore that would significantly impact on the dam and the structures of Rogun HPP.. The same conclusion is reached concerning inflow of sediments. However, such processes and erosion would increase the sedimentation of the reservoir, and the volume and velocity of the sedimentation should be recalculated based on the up-to-date techniques; the scenarios described in these reports are not considered as being sufficiently accurate.

The “Hydroproject Study 2009” report contains the results of the previous study concerning slope failure processes, sediment flows and erosion, but additionally contains the results of the recent investigations and estimations. For instance, sediment load of small tributaries near the dam site, Obi-Garm river, Obichushon, Passimuraho and Obishur valleys, were addressed in more detail. The big volume of sediment stemming from the Obishur valley, on the left bank just downstream of the dam, is of special concern, and measures were proposed. A dam for retaining sediment from this valley is under construction.

The area prone to reservoir bank transformation was estimated to comprise 550 hectares in the Original project of 1978 (page 170-171, table 2.7.3 - volume 1174-T15 “Rogun HPP on the Vakhsh River. Engineering design. Part 1- Natural environment. Volume 3- Engineering-geological conditions” (1174-T15 «Рогунская ГЭС на реке Вахш. Технический проект. Часть 1 — Природные условия. Том 3 — Инженерно-геологические условия»)). However, this area was estimated as being 3500 hectares in the “Hydroproject Study of 2009” (page 9, #1861-2-VIII “Volume VIII – The procedures for reservoir area preparation (№1861-2-VIII “Том VIII Мероприятия по подготовке зоны водохранилища)). The reason for this big difference needs to be clarified..

6.4.2 Salt Stock

The next issue is the salt stock (salt dome) problem. As mentioned in both reports, the salt stock is located close to the upstream cofferdam, and there is a risk that the reservoir will affect vertical movements of this salt stock, which in turn could lead to dam deformations. This was analysed in both reports, and as for the case of sedimentation widely differing conclusions were reached.

The construction of special tunnels to solve the salt stock problem was proposed in the original project of 1978 (№ 561ТП-3VII-2906 “The measures for saline protection of the salt stock. 1978 (№ 561ТП-3VII-2906. Мероприятия по защите пласта соли от размыва. 1978). The main idea is to establish a protection curtain for the salt stock by means of special saline and hydraulic protection using salt brine injections to the salt stock location on both sides of the river near the coffer dam. It was assumed that this measure would exclude the dangerous deformations of the salt stock, and, as a result, dam deformations.

The new study of the salt stock problem is given in “Hydroproject Study of 2009” (#1861-1-KH2. Explanation note. Page 91 – 96. (№1861-1-КН2. Пояснительная записка. стр. 91-96). Physical and numerical modelling were made, and based on the results the estimation of the salt stock movements under the influence of the reservoir was made. Modelling was done for two dam types, concrete dam and embankment dam. For both cases the maximum value of the salt stock dissolving is estimated at less than 7-8 meters. In the same chapter the proposal is made to provide more detailed analyses of the embankment dam rigidity for such changes in the salt stock surface.

6.4.3 Seismicity

A number of questions arise from the analysis of the research concerning the seismic conditions of the Rogun HPP area and dam site. The seismic conditions and seismic hazards assessment are described in detail, but in accord with the rules and codes accepted in the former Soviet Union, Republic of Tajikistan and Russia.

In the original project of 1978 the return period of the earthquake with an intensity of 9 degrees on the MSK-64 scale was assessed as being 1 per 1000 years, and 8 degrees as 1 per 500 years, for the Vakhsh fault zone in the area of Rogun HPP. The background seismicity for the site construction was assessed as 9 degrees, and on the basis of the soil conditions of the site the background seismicity of 8 degrees was recommended (page 197, volume 1174-T15 “Rogun HPP on the Vakhsh River. Engineering design. Part 1- Natural environment. Volume 3-Engineering-geological conditions” (1174-T15 «Рогунская ГЭС на реке Вахш. Технический проект. Часть 1 — Природные условия. Том 3 — Инженерно-геологические условия»)). Moreover, the analysis of the seismic impact on the dam site was based on the existing seismic and active tectonic data for that time period. The conclusion is that a seismic impact estimate of 9 degrees of surface shaking according to the MSK-64 scale for the HPP area, and 8 degrees for the dam site is not sufficient especially today, 30 years after these estimations were reached.

The seismic conditions of the territory of Tajikistan and the Rogun HPP area are described in “Hydroproject Study of 2009” (# 1861-2-II-3 “Volume II - Engineering-geological conditions, Book 3 – Engineering-geological conditions. Chapter 5 (№ 1861-2-II-3 «Том 2. Природные условия. Книга 3 -Инженерно-геологические условия». Раздел 5). The description of the locations of seismic events, seismically active faults, and the history of the seismic hazard assessment are given in this chapter. All estimations indicate an intensity of 9 degrees on the MSK-64 scale for Rogun HPP site.

The return period of an earthquake of an intensity of 9 degrees was assessed as 1 per 100 years. As mentioned above, it is recommended that the return period should be estimated again for explaining the big difference between the results in the 1978 project and the 2009 study.

The calculation of the seismic acceleration is given also. Paragraphs 2.3.4 in detail describe the raw data, utilizable techniques and the results of such calculations, especially for the dam site. Nevertheless, the assessment based on the probabilistic approach is needed in accord with international standards and the rules of the ICOLD.

6.4.4 Reservoir Induced Seismicity

None of the reports provides an analysis of possible Rogun reservoir triggered seismicity. There is only a very short citation of the study of the results of reservoir induced seismicity triggered by Nurek, which leads to the conclusion that the future reservoir will not trigger any big earthquakes, but will increase the quantity of small earthquakes in this area. There is also a note that some research institutes study the reservoir induced seismicity of Rogun (paragraph 1.5 Volume 1174-T15 “Rogun HPP on the Vakhsh River. Engineering design. Part 1- Natural environment. Volume 3-Engineering-geological conditions” (1174-T15 «Рогунская ГЭС на реке Вахш. Технический проект. Часть 1 — Природные условия. Том 3 — Инженерно-геологические условия»)). However, the main problem is that there is no seismic network precise enough in this area. This means that the problem of reservoir induced seismicity was not investigated seriously, despite the well known fact that the seismic potential of this area is very substantial. It is recommended that a state of the art digital seismic network should be installed as soon as possible in the area of the dam and the future reservoir.

6.5 Preliminary Recommendations

Through the study of the available documents and some short site visits the Consultant came to the following conclusions and recommendations:

- An analysis of areas prone to erosion around the future reservoir should be carried out, especially in order to check the reasons for the big difference in this estimation between the 1978 and the 2009 studies.
- For the same reason, the risks stemming from the salt stock in the immediate vicinity of the dam should be reassessed.
- The earthquake risk should be reassessed, and present day international standards should be applied.
- The problem of reservoir induced seismicity has not really been addressed so far. This should be done urgently, and it requires the installation of a state of the art seismic monitoring network.

6.6 Work to Be Done in the Next Phase.

Additional information on slope stability and estimation of the reservoir bank transformation around Rogun reservoir and dam site was received recently(Geological Department report 1989). This will have to be analysed in detail.

Furthermore, the situation and the results of the available studies need to be discussed with the TEAS consultant. The questions about the assessed stability of the underground power house under the seismic impacts and rock creep will be discussed, especially the section of the power house in the siltstone. The recommendations about the earthquake risk estimation for dam site in accord with international standards include the slope stability under seismic load impact around the reservoir area. The same concerns the salt stock problem, because a big differences was found the technical report 1978 and the Hydroproject study 2009.

The preliminary recommendations given above might have to be revised depending on the results of these further steps.

7 CLIMATE

7.1 Theoretical Considerations

Large water bodies influence the climate of their surroundings, especially temperature and humidity. The most noticeable effects are a general cooling in summer, a warming in winter, and a reduction of the daily and seasonal temperature variation. This effect can be clearly seen when the climate of a place on the seashore, with maritime climate, is compared to the one of a place far away from sea influence, with a continental climate type. Direct measurements have documented this effect. So it has been demonstrated that for instance an small island in the Finnish Bay exhibited a January temperature that was 1.3°C higher than that of a station in the nearby land some distance away from the coast, while the average May temperature was 2.5°C lower. Similar, although smaller effects have been demonstrated in the vicinity of two lakes (Lake Peipus, Lake Chelkap), although in these cases the differences were smaller, reaching only +0.3° in winter, -0.7° and -1.8°, resp., in summer (Alissow et al., 1956). This is also illustrated for Lake Aral in Fig. 5-2.

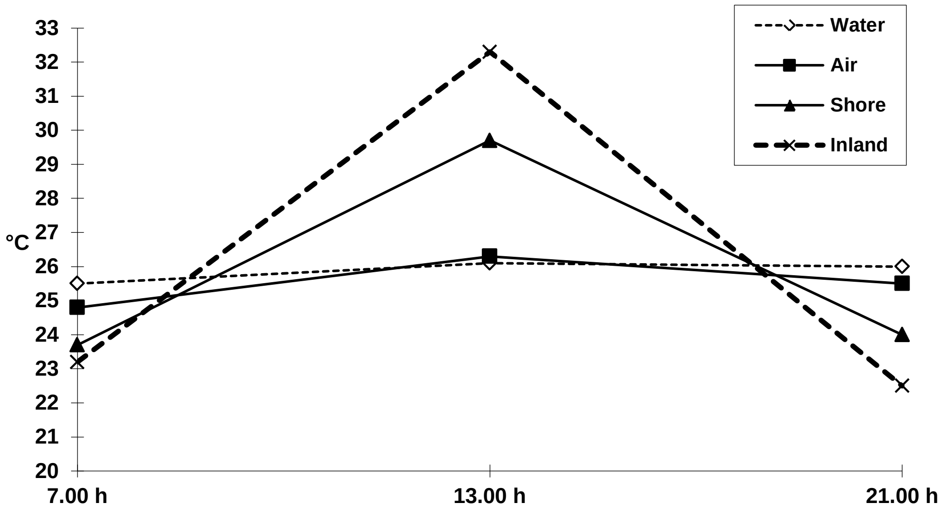

Figure 7-1: Daily temperature variations as influenced by a lake

Measurements from Lake Aral, August 1902. The daily amplitude of water temperature is merely 0.6°, of the air above the water 1.5°, at the shore 6.9° and in greater distance from the lake 9°C (Alissow et al., 1956).

This is mainly due to the fact that the water is able to store a considerable amount of heat, and that it reacts very slowly to changing temperatures. While on land the temperature (soil and air layers close to it) can exhibit large daily fluctuations, this is not the case for water. In Irkutsk, the daily variation in summer is 13.5 to 21.7°C, in winter 5.7 to 14.5°C (air 2 m above ground), the soil surface variation is even greater (29.8° in summer, 6.2° in winter; measurements for a day with rather low air temperature variation). It will be noted that Irkutsk is exhibiting a continental climate in spite of the proximity of Lake Baikal, which is one of the largest inland water bodies of the world. The biggest daily variations in air and soil temperature are recorded from deserts, which lack the cooling effect of evapotranspiration. In African deserts, daily surface temperature differences of up to 43°C have been recorded, in middle Asian deserts up to 50°C.

In larger water bodies (seas and very large inland waters), normal daily fluctuations of temperature close to the surface are usually below 1°C (and smaller for deeper layers), and this is also the case for the air layer of approximately one meter above the water surface, this difference getting more pronounced in higher air layers (Alissow et al., 1956; Geiger, 1950).

In the case of smaller lakes, it is very difficult to define clearly the effects of the proximity of the lake on ambient temperatures, as the complex mixing processes due to local winds tend to blur this influence. Nevertheless, it can be said from experience that, as a general rule, lakes have a beneficial effect on the local microclimate. This is shown by the fact that, in temperate regions, some plants normally limited to a warmer climate grow exclusively or at least much better in the vicinity of lakes (e.g. vineyards in central Europe). Furthermore, settlements tend to concentrate around lakes. While this has certainly different reasons, historical and scenic ones among others, the microclimate certainly contributes to it.

In temperate and cold regions, the effect of a lake on the climate takes place only while it is not covered with ice. A compact ice layer covering the water body effectively blocks temperature exchange of the lake with its surroundings.

A few publications are concerned with the question of evaporation form lake surfaces (Kuhn, 1977; Hoy and Stephens, 1977). However, there does not seem to exist, to date, a thorough climatic study in relation with a man-made lake, which would compare temperature and humidity values before and after dam construction. The studies that at least mention potential climatic effects of artificial lakes attribute to them a minor or almost negligible effect (e.g. Odingo, 1979; Olivetti, 1983). this seems perfectly understandable given the fact that, while artificial lakes certainly create considerable impacts on the environment, climatic changes can, in the light of the details given above, be considered as of minor importance and, if at all noticeable, then rather beneficial.

7.2 Climatic Situation

A short description of the climatic situation is given here, based on data from meteorological stations in the project area.

7.2.1 Temperature

As can be seen from the following graph, which shows average monthly temperatures from two stations (Komsomolobod within, Garm just upstream from the future reservoir), the area shows a distinctly continental climate, with marked differences between summer and winter.

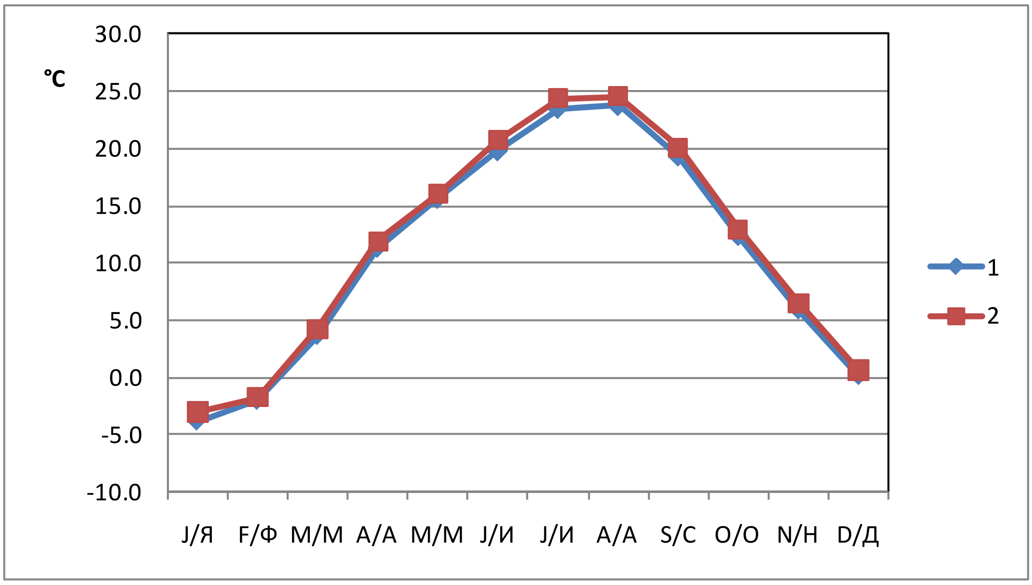

Figure 7-2: Average monthly temperature

1 = Garm 2 = Novobod (Komsomolobod)

The following Figure shows the average yearly, summer and winter temperature for Rasht (Garm) over the available period 1933 - 2010 (with, as is the case for many measurements, a gap between 1992 and 2006). The data do not show any trend for the time span on record.

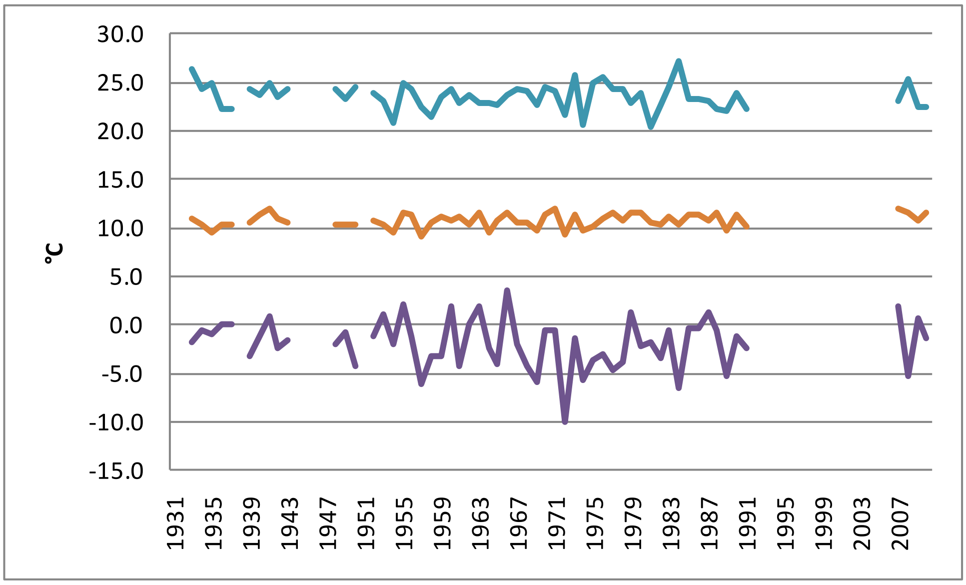

Figure 7-3: Temperature 1931 to 2010

Hottest month (August, top), yearly average, coldest month (February, bottom)
Source: Hydromet, Tajikistan; 58 years with complete records (Rasht, Garm)

7.2.2 Precipitation

The three stations within the project area for which data on precipitation are available all show the same pattern of yearly distribution of precipitation: the maximum is in winter and spring (December to May). Much of this falls as snow, especially at higher altitudes. In the summer months there is very little precipitation.

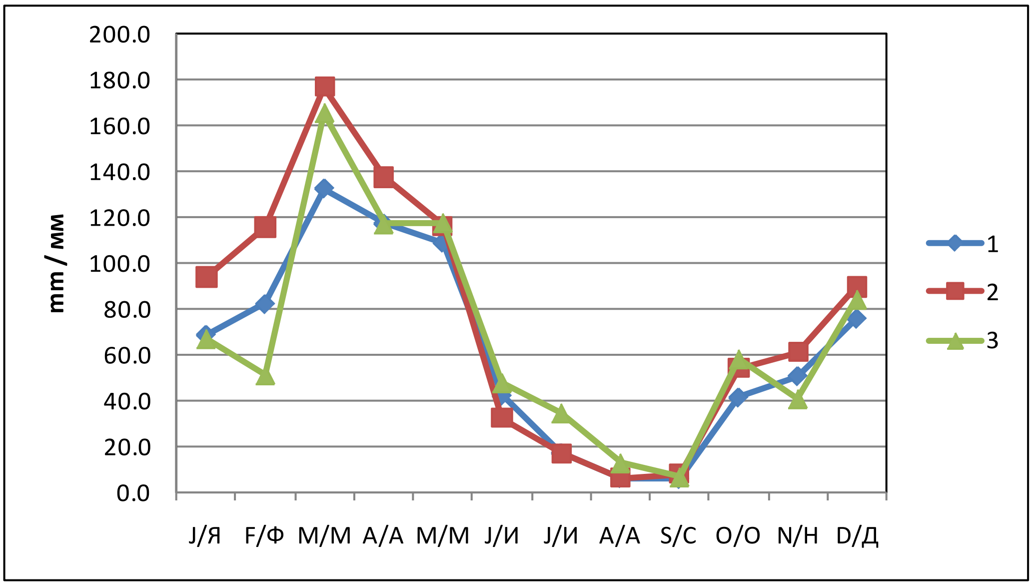

Figure 7-4: Average monthly precipitation

1 = Garm 2 = Novobod (Komsomolobod) 3 = Obigarm

This pattern of rainfall is typical for the mountainous regions of Tajikistan, but is basically the same for the lower laying areas, which however receive less precipitation in total. This lack of precipitation, and especially rainfall during the vegetation period, is the main reason why agriculture depends almost exclusively on irrigation.

7.3 Effects of Rogun Reservoir on Local Climate

The presence of a surface of water of 170 km³ will increase evaporation, and it can have a moderating effect on temperature. However, the lake will be too small for having have a noticeable effect on the climate. The effects (reduction of the number of frost days, reduction in summer temperatures, increase in humidity) will be limited to the immediate surroundings of the reservoir, and they will be too small to play any decisive role.

7.4 Climate Change

It has to be stated clearly that the concept of Climate Change refers to the effects observed on a global level, induced by man-made greenhouse gas emissions, and that this is a very different issue as the effect of the reservoir on local climate, which was discussed above. Here, the focus is on effects of climate change on water availability for hydropower production (and for irrigation, as far as this is of concern in the context of this ESIA). Obviously, the fact that reservoirs, under certain conditions, can be sources of greenhouse gasses has to be taken into account (see Section 8.6.2).

7.4.1 Expected Development in the Project Area

Expected effects of climate change in the project area can be estimated from the following Figure.

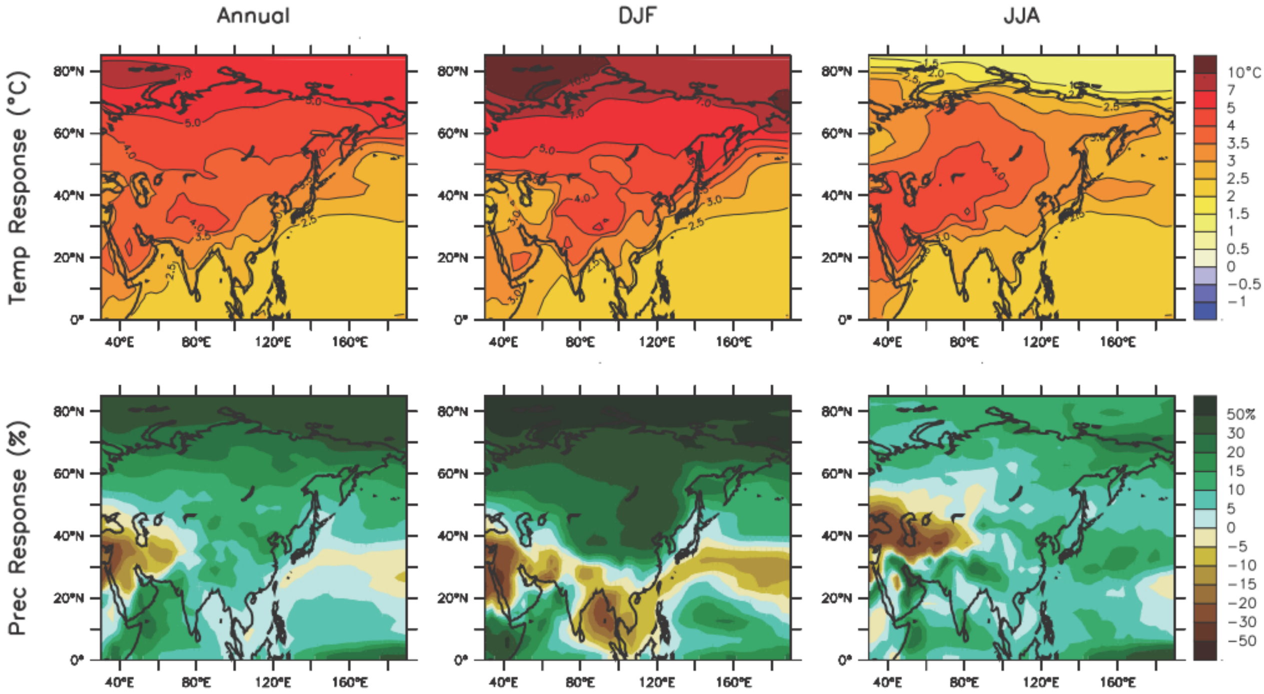

Figure 7-5: Expected climate change in Asia

Source: Christensen et al. 2007

The most important results of this analysis for the project area are the following:

- Temperature is expected to increase by 3.5-4°C. The effect will be more marked in summer, but winter temperatures will increase by a similar extent. In general, it is assumed that an increase in temperature by 1° leads to a rise in the snow line of about 150 m. In the case of the Vakhsh catchment, with its high proportion of high mountains, this could have a significant effect on snow cover and therefore on river runoff.
- Overall, a small increase in the total amount of precipitation is predicted. What might be more important in the case of the study area, however, is the shift in seasonal distribution: increase in winter, decrease in summer. This would mean that the situation shown above, with humid winters and dry summers, will become even more accentuated.

A more detailed analysis of the situation will be provided in the ESIA.

7.4.2 Analysis of Climate Change Effects

7.4.2.1 Analysis According to TOR

The TOR for the ESIA Rogun, in Box 8, state the following:

Hydrology and Climate Change Impacts

The impacts of Rogun HEP construction and operation should be seen within the context of global climate change, which might significantly affect the physical environment of the project. The Consultant should describe and whenever possible quantify processes and factors such as:

- temperature impact change on water balance models of mountainous regions, on glacial melting, water generation from fossil ice vs. annual replenishment by precipitation, water storage in glacial systems, timescale of balance of deposition and depletion
- changes in amount, type and seasonal/annual distribution of precipitation in the project area and the upstream / downstream watershed of Rogun HPP
- changes in reservoir temperature and resulting stratification / mixing behaviour due to change of average ambient temperature as well as water temperature of Vakhsh river and other direct inflows, impacts on reservoir water chemistry, fauna and flora
- changes of upstream / downstream hydrological parameters, notably flow rates and sedimentary load and their seasonal / annual distribution. They might be controlled by underlying phenomena such as glacial melting and subsequent release of water / sediment trapped in ice, glacial retreat and exposition of additional areas to erosion, changes in vegetation and resulting impact on erosion / sediment generation and microclimate
- changes in seasonal / annual demand patterns for water and electricity: shifts in peak demands for energy (heating / cooling) and water (agriculture, irrigation) in the annual cycle, and interaction of these changes with operational requirements and hydrological parameters, such as seasonal flow rates;
- Review the data on the past climate change in each of the countries in the region and all available future climate change forecasts and assess their impact (a) on the water demand in each country and (b) on the design and operation of Rogun;
- Review the Carbon dioxide emission data in all the five countries and analyze the extent to which Rogun could help to reduce them and outline possible carbon financing mechanisms.

The Consultant is not expected to deliver detailed, quantitative studies on the listed topics, but will analyze them in a comprehensive, qualitative manner, procure quantitative data where available (e.g. from existing global climate models - GCMs) and supplement own best estimates whenever reasonably possible. The Consultant will analyze existing conflicts due to competition among different water uses and develop scenarios how such conflicts would be affected by likely climate change scenarios.

The Consultant will not be required to conduct own basic research, but use available scientific and technical publications and reports.

7.4.2.2 View of the POE

During the visit of the POE for Rogun HPP the issue of climate change was discussed. The POE brought up the following reasoning:

One important topic of the study - and one of the politically very sensitive issues of this project - is its potential effect on riparian countries. Here again, availability of water and its seasonal distribution is of concern for the downstream users of the water, mainly Uzbekistan and Turkmenistan. The effect of Rogun HPP, during the filling and the operation phase, on downstream flow characteristics has to be analysed carefully. However, it is absolutely possible that the effects of climate change in the Amu Darya catchment - which is not limited to the catchment of Rogun HPP - will have a much more decisive impact on amount and distribution of rive discharge in the future. If this is not analysed carefully, all effects will be allocated to Rogun. For this reason, possible effects of climate change in the catchment of Amu Darya should be analysed in detail.

7.4.2.3 Consequences and Conclusions

It is obvious that a comprehensive assessment of climate change effects goes well beyond what was asked for in the TOR. On the other hand, there can be no doubt that this is an important and potentially far reaching issue.

We have prepared a short outline of what should be done in order to address this issue in the way suggested by the POE. The two most important points are the following:

- Collection of the relevant date for the entire Amu Darya basin; in addition to Tajikistan this would mean mainly to obtain data for Kirgizstan and Afghanistan, since both of these countries have an important share of the catchment.
- Application of state of the art models for assessing the expected impacts of climate change on change of precipitation patterns, melting of glaciers, and runoff of rivers.

A somewhat more detailed description of the proposed approach is provided in Annex 7. While we have the models, and the required experience to apply them in a meaningful way, getting the required data might be an additional challenge.

In order to be able to integrate the results of such a study in the overall impact assessment for Rogun HPP, we need to obtain an answer to this proposal as fast as possible.

8 WATER

8.1 Theoretical Considerations

An HPP will normally have influence on surface water bodies in three ways, namely:

- By changing water discharge patterns downstream of the dam.
- By creating a lake, i.e. by changing a portion of the river from its natural running water into a stagnant water condition; this also has implications on water quality.
- By potentially changing the water balance locally (gains from direct precipitations, and losses from evaporation and infiltration).

8.1.1 Downstream Hydrology

A dam and the reservoir, in relation with turbine operation, can change the river discharge downstream of the dam considerably. This is especially the case in strongly seasonal climates with a marked change between rainy and dry seasons. In such cases, water is stored during the wet period to be released during the dry period; therefore, the seasonal variation will be less marked than under natural conditions; this is shown, for one real case, in the following Figure.

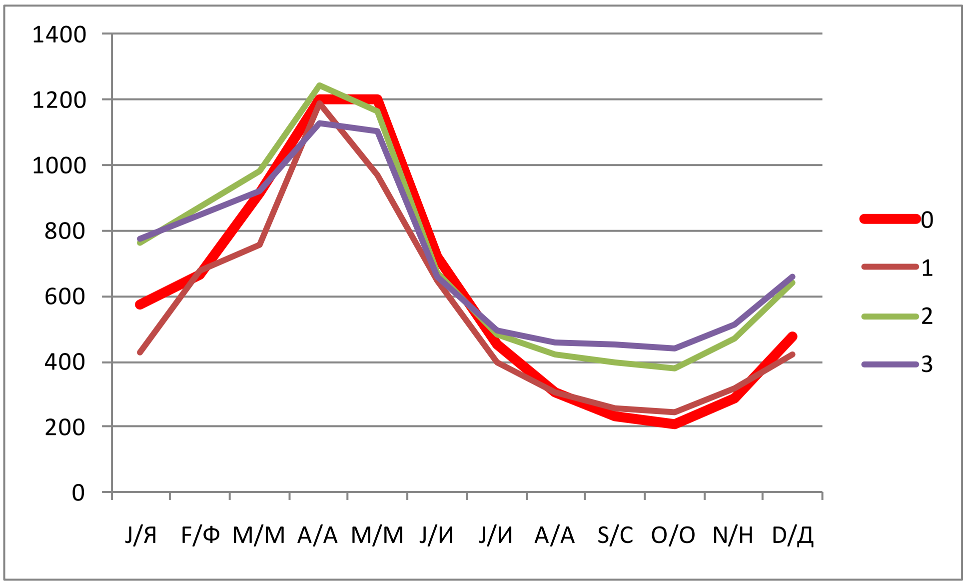

Figure 8-1: Cumulative effects of storage dams (Karun river, Iran)

0 = natural conditions, no dam; 1-3: situation with 1 to 3 dams. It can be seen that each additional dam has the tendency to increase the effect of reducing wet season flows and increasing dry season flows.

Reservoirs have a flood mitigation effect, depending mainly on their size and storage capacity. While attenuating effects on river flows, and especially reduction of flood peaks, are normally welcome by people living along the river, other effects can be less beneficial, and certain floodplain habitats that depend on river dynamics might be negatively affected (see Chapter 12).

8.1.2 Residual Flow

Other effects of the HEP are short term fluctuations caused by turbine operation. When the powerhouse is not situated directly below the dam, but further downstream, a stretch of the river between dam and water outlet will eventually become completely dry. Hydropower projects designed for peaking production can lead to very marked short term fluctuations in river flow directly below the power house. This is shown for one example in the following Figure.

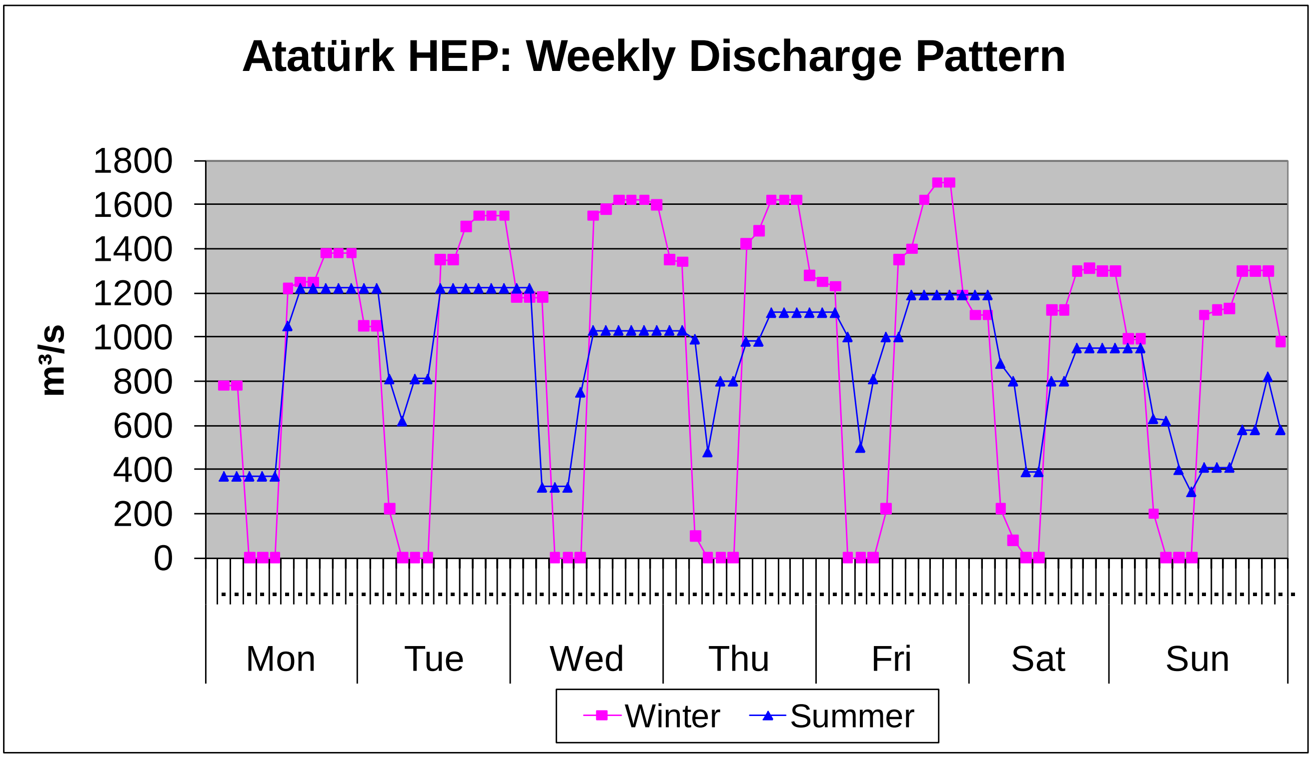

Figure 8-2: Discharge from a peaking hydropower plant

Example of Attatrürk dam, Turkey; it is evident that discharge, and therefore river flow below the power house, change very markedly each day. In winter, there are a few hours each day with zero flow.

In cases where zero flow can occur, the definition of a residual (often called environmental or ecological) flow has to be defined in order to (i) maintain the river as a habitat for aquatic species and (ii) preserve downstream socioeconomic water uses.

8.1.3 Changing River to Lake Habitat

A reservoir or a lake presents very different living conditions for aquatic organisms in comparison to those that prevail in a river. Many riverine species will not be able to adopt to these new conditions, while others will thrive. This aspect will be dealt with in Chapter 11.

8.1.4 Water Quality

Reservoir water quality will depend to a great deal on the preimpoundment condition of the reservoir area. Whenever a large amount of biomass is submerged, the rotting plant material will lead to water quality deterioration in the deeper layers of the reservoir.

This in turn can lead to fish deaths, but it can also impair water quality downstream of the dam. This aspect is especially important when the river or the reservoir itself are used as a source of drinking water. Water quality in the reservoir will also be influenced by input from the catchment area. Namely, large settlements and/or industrial activities without proper waste water treatment will influence water quality. Effluents from agricultural areas can lead to high input of fertilisers into the reservoir, which in turn leads to reservoir eutrophication.

8.2 The Amu Darya Basin and the Aral Sea

8.2.1 The Aral Sea

The Aral Sea is a large lake without effluent, an as all of these lakes it depends entirely on its tributaries. Around 1960, it had a surface of 66'458 km² and was then the fourth largest lake in the world in terms of surface area. Average depth was 16 m, maximum depth was 68 m in the western and 29 m in the central and eastern part; these two parts were separated by islands which today form an almost complete separation between the two parts.

In historical and prehistorical times, the lake level has known rather important fluctuations, the amount of which is still a matter of debate. However, at least for a time span of at least two centuries before 1961 it has been very stable, with a variation in the order of magnitude of 1-2 m.

The Aral Sea has only two tributaries of importance, the Syr Darya in the North and the Amu Darya in the South, both originating in the high mountain areas to the east of the lake, in Kirgizstan, Tajikistan and Afghanistan. Records from the 20th century show that the overall runoff of the Amu Darya at the foothills of the mountains (i.e. in the region of Termiz, a short stretch d/s of the Tajik-Uzbek border) was 78.6 km³/y, with high yearly fluctuations, however without showing a downward trend (see Figure 8-3). Out of this, originally (i.e. before about 1960) around 50 km²/y reached the Aral Sea (see Figure 8-5). The fact that in spite of the high yearly variation of inflow the lake level remained rather stable might have been due to the mitigating effect of the groundwater reserves in the soils along the river plains and the lake.

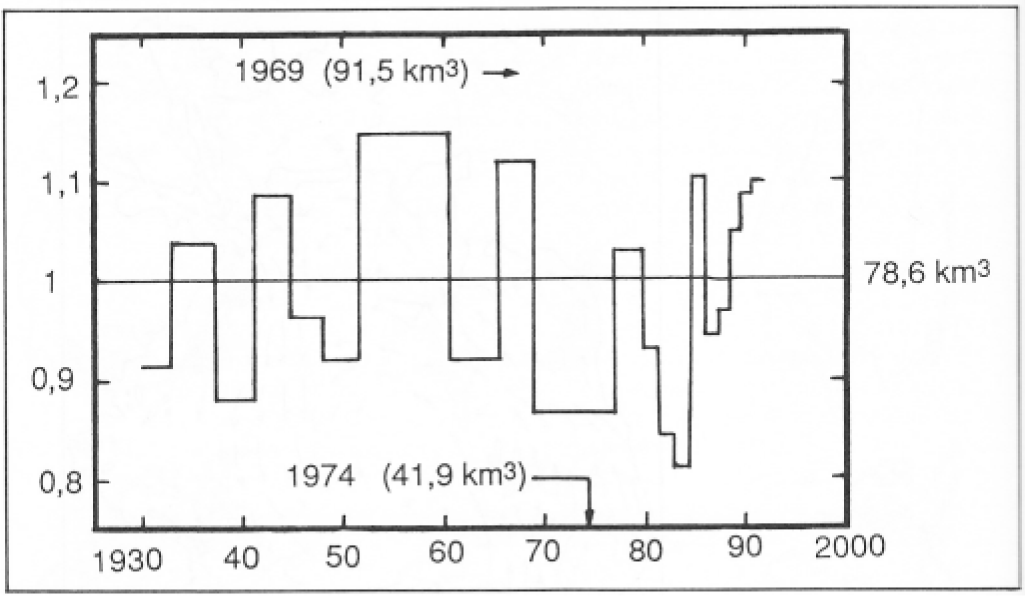

Figure 8-3: Overall water inflow into the lower Aral basin

Source: Létolle et Mainguet 1993: 50.

8.2.2 Amu Darya

The origin of the Amu Darya (which has this name only from the point of the confluence of its main tributary, the Pyanj, with Vakhsh, 1445 km upstream of the lake) is in the Pamir, in Afghanistan, close to the Chinese border, at an altitude of 4900 m asl. The total length of Pyanj-Amu Darya is 2540 km. The total catchment area is 309’000 km^2. Most of its water stems from snow and glacier melt. Two major tributaries come from Afghanistan, the Kochka (u/s from Pyanj-Vakhsh confluence) and the Kunduz (between Vakhsh and Kafirnigan), bringing about 7 to 8% of the total flow. These two rivers form extensive floodplains near the city of Termiz, which marks the end point of the mountainous section of Amu Darya. Further East, there are no other major tributaries. The Amu Darya is a highly seasonal river, as shown in the following Figure.

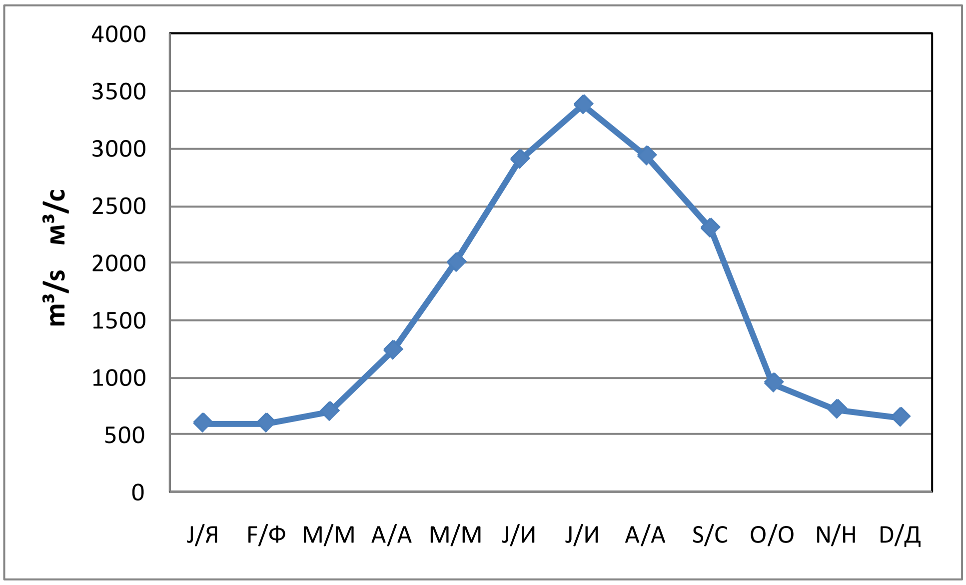

Figure 8-4: Monthly discharge of Amu Darya at Kerki (1959, 50 year average)

Source: Létolle and Mainguet (1993: 58)
Kerki is located in Turkmenistan, about 250 km downstream from the Tajik-Uzbek border.

The water of Amu Darya is very hard (high concentration of calcium carbonate), and its content in organic matter is very low, due to the low content of humus in the catchment area. Salt content has increased markedly due to drainage water from irrigated areas and waste water inflow from settlements.

8.2.3 Development in the 20th Century

After the end of World War II, and especially towards 1960, large irrigation projects were implemented in the Aral basin, along the Amu as well as the Syr Darya (see Figure 8-7).

This increased the irrigated area and agricultural productivity mainly in Uzbekistan and Turkmenistan (for the Amu Darya), but it also had the immediate effect of massively increasing water abstraction from Amu Darya, thus reducing inflow to the Aral Sea (see Figure 8-5).

The massive reduction in inflow had as consequence a very marked reduction in the total amount of water in the Aral Sea, since the losses from evaporation were no longer compensated. This meant that the level of the lake decreased, (from around 53 m asl before 1960 to 42 m asl in 1985), and the surface shrunk from 65’000 km² to 45’000 km² in the same time span.

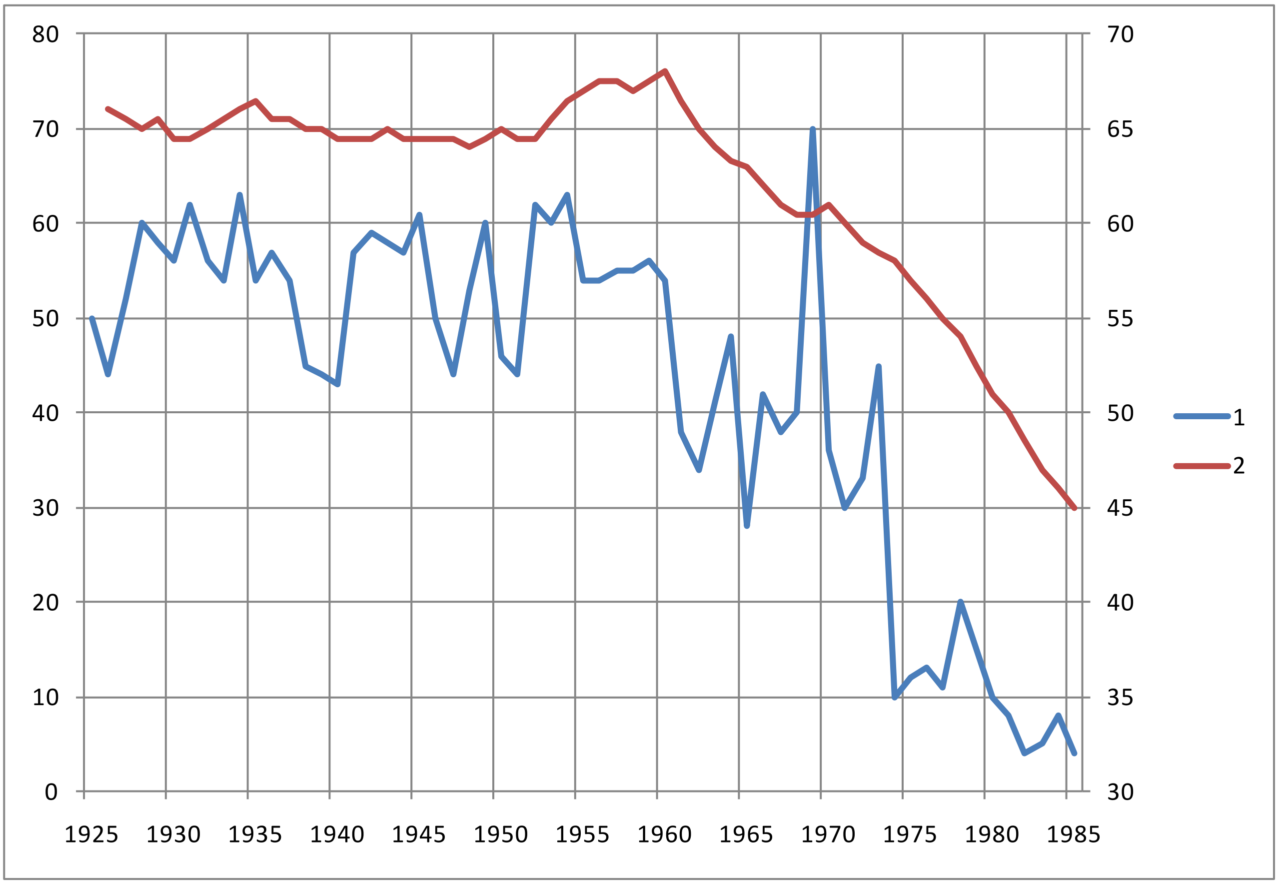

Figure 8-5: Inflow to and surface of Aral Sea

1: inflow to Aral Sea (in km³/y, left axis)
2: surface of Aral Sea (in ‘000 km², right axis)
Source: Létolle and Mainguet, 1993 (p. 186)

8.2.4 Present Situation

This development has continued since 1985, as can be seen in the following Figures, which show the shrinking water surface from 1960 to 2009.

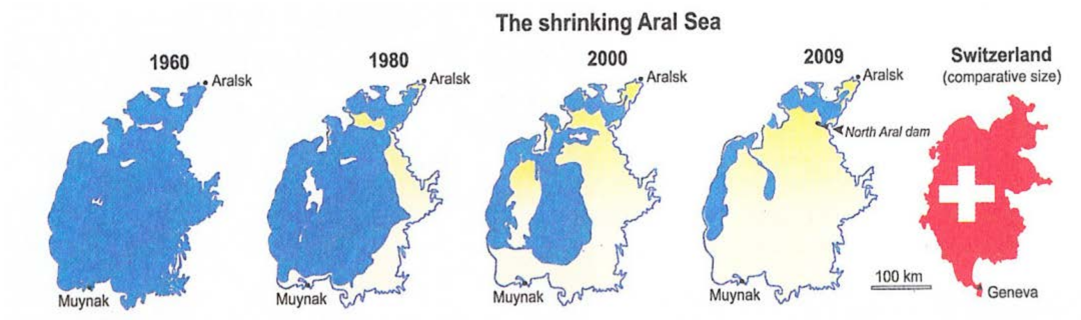

Figure 8-6: Aral Sea 1960 - 2009

Source: WWF 2010

The present situation of water use in the Amu Darya basin is shown in the following Figure.

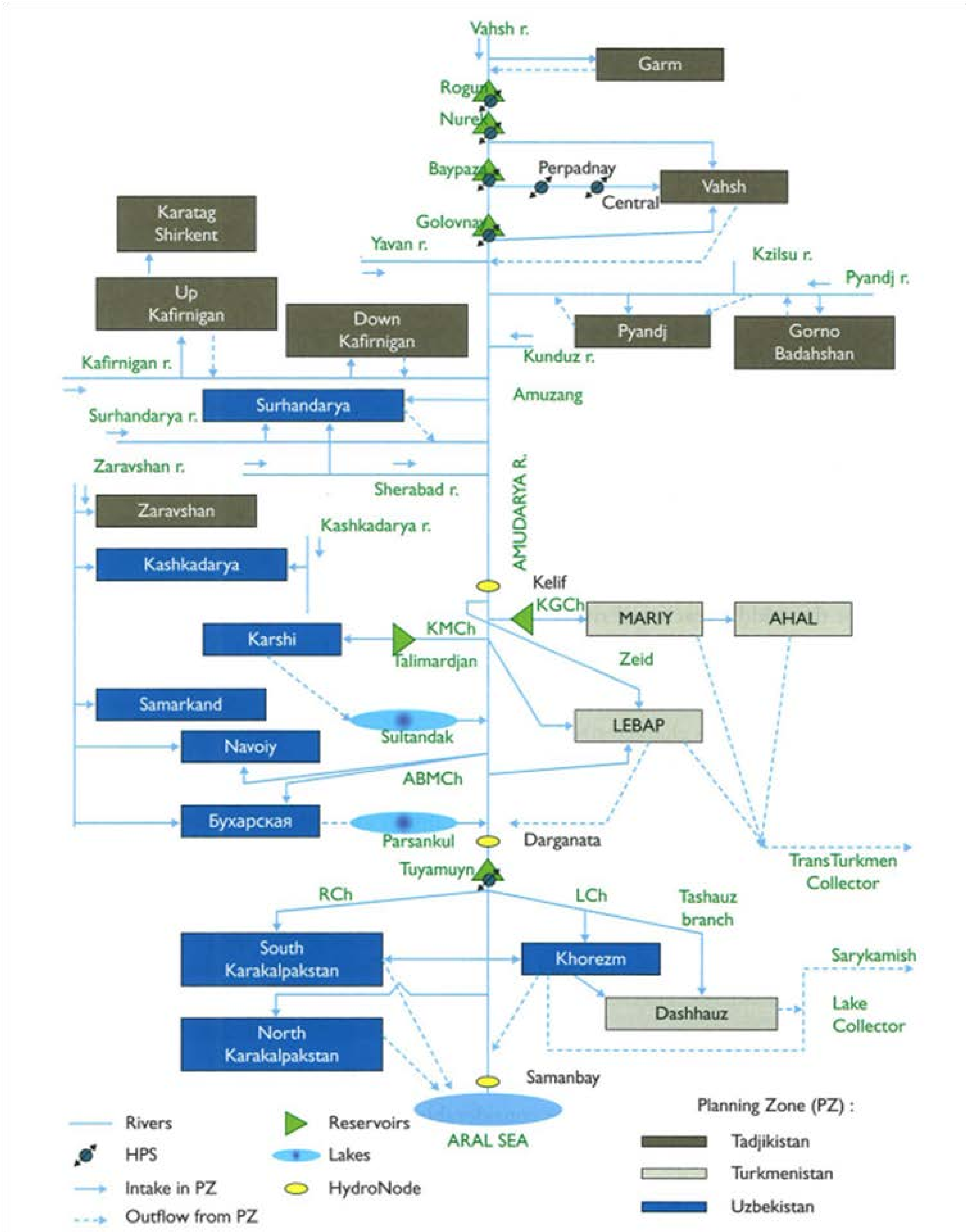

Figure 8-7: Present water use in the Amu Darya basin

Source: Dukhovny and de Schutter (2011)

8.2.5 Water Uses in the Amu Darya Basin

8.2.5.1 Irrigation

Historical development of irrigation: Until the 1950s, irrigation water demands were relatively low and the Amu-Darya river was regularly discharging into the Aral Sea. Since the 1960s, however, the large-scale opening up of new lands through irrigation disrupted the equilibrium between the water demand of man and that required for a balanced functioning of Amu Darya and Aral Sea water bodies (**Error! Reference source not found.**).

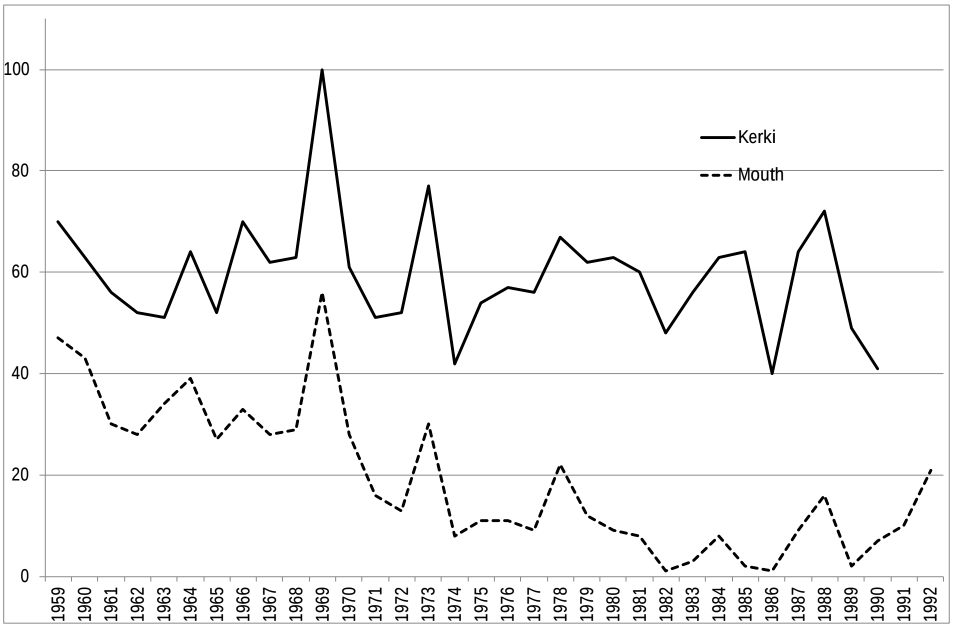

Figure 8-8: Amu Darya annual discharge in Kerki (middle course) and in the Aral Sea
1959 to 1992 (source: FAO, 1995)

The period between 1950 and 1990 saw huge investment in the water infrastructure of the region with the construction of reservoirs, irrigation canals, pumping stations and drainage networks to support the cultivation of cotton, wheat, fodder, fruit, vegetables and rice in the arid steppe and desert areas. In 2005-10, the area under irrigation in the Amu Darya basin exceeded on average 5 million hectares (ENVSEC, 2011). The actual area under irrigation each year depends on the climatic conditions of the current year as authorities decide how much land can be put under irrigation. Uzbekistan has the largest area under large-scale irrigation followed by Turkmenistan, Tajikistan and Afghanistan.

Compared to other water uses, irrigation is by far the main source of water abstraction in the Amu Darya basin (see the example of year 1997 in the following FigureFigure 8-9).

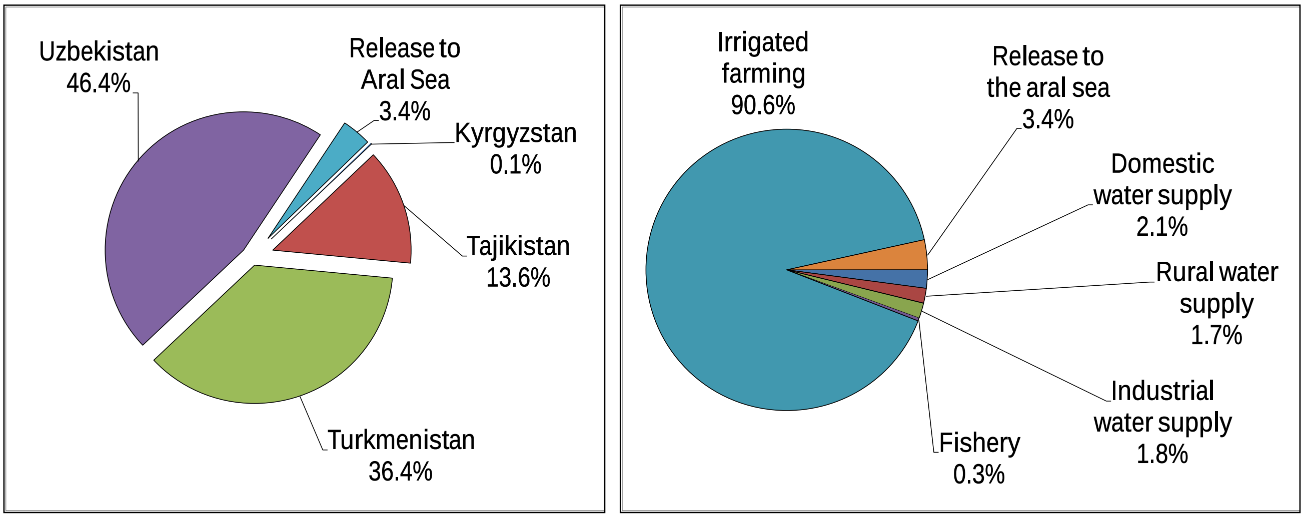

Figure 8-9: Country and sector distribution of Amu Darya water abstraction (1997)

Source: BVO

The largest irrigation canal is the Karakum Canal (Garagum Darya), the main section of which was completed in the 1960-70s to carry water from the Amu Darya at Kerki, Turkmenistan, westward to Mary, Ashgabat and ultimately to the Caspian region.

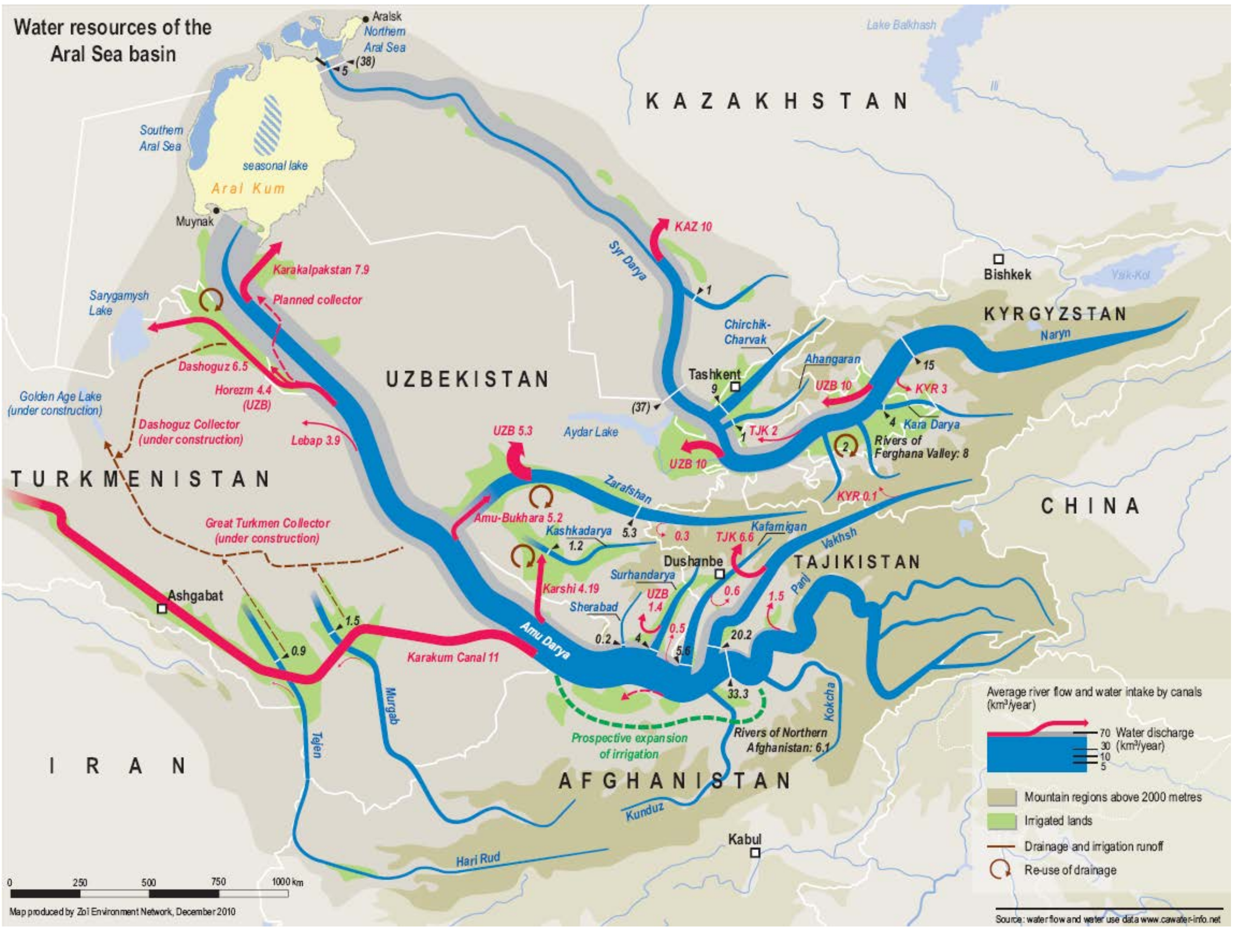

Figure 8-10: The use of water resources for irrigation in the Aral Sea basin

Source: ENVSEC, 2011

Drainage : Apart from water abstraction, 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). Greater amounts of drainage water are diverted into the deserts and other lands deemed unsuitable for cultivation.

Overall, drainage water constitutes 30% of the water consumption in the Amu Darya basin. 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, while much of it 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.

Irrigation schemes along Vakhsh river : Within Tajikistan along the Vakhsh river, there are several irrigation schemes. They all are located downstream from Nurek HPP:

- The Dangara tunnel with a capacity of 100 m^3/s was built to irrigate the land in Dangara area (70 000 ha) through a tunnel from the Nurek reservoir.
- The Yavan tunnel with a capacity of 75 m^3/sec. The tunnel irrigates the land in the regions of Yavan, A. Jomi and Hurason. The water intake is connected to the Baipaza reservoir.
- The Vakhsh main canal with a capacity of 210 m^3/sec is used to irrigate the land in the regions of Vakhsh, Bokhtar, Jilikul, Kumasangir and Rumi.

In addition to these major systems there are also several small size irrigation systems that provide public and private farms with irrigated water ; their abstraction capacity usually does not exceed 1 m^3/s (observations made on site along the Vakhsh river).

Finally, it should be noted that a significant part of agricultural land in Southern Tajikistan is currently not irrigated because of the too poor conditions of the irrigation infrastructure. The rehabilitation of these irrigation systems would result in increased water withdrawals from Vakhsh river.

Seasonality : Most of the water abstracted for irrigation is abstracted during the vegetation period which, subject to the altitude and type of crop, extends from April to October.

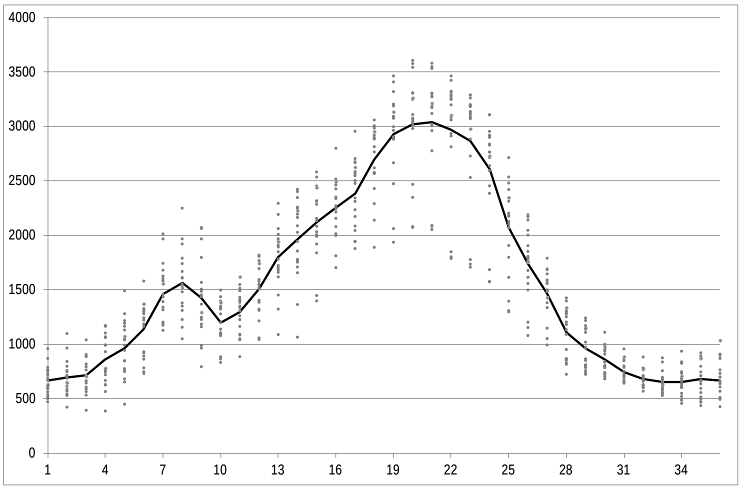

Figure 8-11: Seasonality of water abstraction (1992-2010 data per decades, m³/s)

8.2.5.2 Hydropower

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

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 hydrology of the Amu Darya. The Kafirnigan river basin also accounts several small run-of-river hydropower schemes, notably in the Varzob river close to Dushanbe. In Uzbekistan, hydropower schemes are existing in the Zeravshan and Kashkadarya basins (notably, Gissar HPP).

Table 8-1 shows the characteristics of the existing hydropower schemes along the Vakhsh river. The latest development occurred in 2011 with the commissioning of new turbine in Sangtuda 2.

HPP	regulation capacity	reservoir			installed capacity, MW	Head, m
		total volume km³	active storage km³	surface km²		
Nurek	annual	10500	4536,8	98	3000	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	-

Table 8-1: Vakhsh river cascade HPPs characteristics

Nurek HPP was commissioned in 1972. It is the largest HPP, and the second largest regulation reservoir in Amu Darya river basin (after Tyuyamuyun reservoir in Uzbekistan).

Notably, Nurek is the tallest dam in the world, and provides around 80% of the electricity used in Tajikistan.

Nurek is the only reservoir in upper Amu Darya basin (i.e. in Kafirnigan, Vakhsh and Pyanj basins) with an interannual regulation capacity. Other HPPs located in the upper Amu Darya basin have in the best case a weekly (Baipaza) or daily (for peak production) regulation capacity.

Photo 8-1: Nurek reservoir from dam crest

In the lower Amu Darya, Tuyamuyun is the only reservoir with hydropower production capacity.

8.2.5.3 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 on 2 000 km, from the Aral Sea to the lower reaches of Pyanj River (Annales de Géographie, 1953).

Historical data indicate 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 1980's by the construction of Tuyamuyun dam.

Photo 8-2: Navigation on the Amu Darya, around the 30's

Source: www.karakalpak.com

In addition, water abstraction 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 and on the Vakhsh and Pyanj rivers is nowadays limited to local activities using small size boats: local transportation, fishing, tourism, riverworks…

8.2.5.4 Domestic and industrial uses

Water abstracted or diverted from the Amu Darya basin is in majority (over 90%) used for irrigation needs, but also for domestic and industrial needs.

The volumes of water used for industrial, rural and urban needs are in the same order of magnitude: around 2% of the volumes abstracted from the Amu Darya.

8.2.5.5 Fisheries and aquaculture

In Tajikistan and Vakhsh river: In Soviet times, fish production largely focused on pond culture. Kuybyshev, the first hatchery, was established at Vakhsh in Khatlon oblast in 1951, when the Vakhsh River changed course leaving a series of large ponds on its original watercourse. Originally covering 72 ha, the farm expanded within the space of 20 years to cover more than 200 ha and to produce 14 million larva for domestic and export purposes, after scientists introduced new herbivorous species (principally carp and bighead) into these ponds and established a small hatcheries facility in the early 1970s. 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. 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.

Photo 8-3: Kuybyshev fish ponds along Vakhsh river

Source: Google Earth

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. The company sells fingerlings to pond culturists, including dekhan farms, and retails grown fish through shops in the capital of Dushanbe (FAO, 2009).

Fish breeding in Tajikistan reached its zenith in 1991. In that year, pond culture, which contributed 3'298 tonnes or 84% of the total fish production, was largely focused on carp and smaller quantities of freshwater bream.

Commercial fishing was most in evidence at Kayrakkum, in the Syr Darya basin. Since 1991, however, there was a severe decline in production, as a general consequence of the deterioration of the economic and environmental situation. The country's only trout cage-culture facility on the Nurek reservoir was destroyed during the civil war.

Along Amu Darya river course: The ecological degradation in the lower reaches of the Amu-Darya as well as the construction of dams and barrages and diversion of water for irrigation use has resulted in a dramatic change in fish stocks of the major rivers, with sturgeon, shovelnose and Aral trout virtually disappearing from them. While formation of reservoirs provided new environment for lacustrine fish species, these had to be introduced, largely from the Far East. Pollution through agrochemical inputs has also caused a major problem. The future of the fishery in the lower Amu-Darya depends much on solving the problem of the Aral Sea and its catchment. The FAO considers that only the implementation of a water resource rehabilitation programme could lead to the rehabilitation of fish stocks and fisheries.

Since November 2009 the Central Asian Republics are being supported in the rehabilitation of their fisheries and aquaculture sector by the Food and Agriculture Organization of the United Nations (FAO).

8.2.5.6 Environmental needs

Along the Vakhsh and Amu Darya rivers courses, there are three protected areas which are highly depending on the river flows:

Tigrovaya Balka reserve (Tajikistan) is a 40 km long alluvial plain where unique ecosystems are growing on the Vakhsh river deposits. The Vakhsh river itself is meandering within this area. Conservation programs are being implemented in Tigrovaya Balka, in order to save the internal ponds and oxbow lakes. Tigrovaya Balka has been affected by agriculture developments and the release of drainage water. It is also likely that the reduction of sediment transport in Vakhsh river after Nurek HPP construction resulted in a lowering of the river bed, and this in turn induced a reduction of the water table within the reserve.

Aral Paygambar reserve (Uzbekistan) is an island located in Amu Darya river bed. It is 3000 ha (including 900 ha of tugai forest) and hosts a very fragile ecosystem. It is a protected entity since 1971.

Amu Darya Nature reserve (Turkmenistan) was established in 1982 and covers a total of 485 km². It is split into three separate sites in the middle reaches of the Amu Darya River: Nargiz (45’100 ha), Gabaklinskiy (1’200 ha) and Gereldinskiy (2’200 ha). Valley flood plain tugais and salt pans of the Turan lowlands are well represented. The territory of the Reserve includes part of the Amu Darya River.

The environment of the three above mentioned reserves is highly dependent on the neighbouring river flows which feeds the water table and allows the preservation of these specific habitats. Significant changes in the river flow might affect these habitats either through erosion, flooding or underground water level depletion processes.

Finally, the **Aral Sea** which ultimately collects water from the Amu Darya used to be an environmentally rich area. The Aral Sea formerly was one of the four largest lakes in the world with an area of 68’000 km²; it has been steadily shrinking since the 1960s because of the diversion of Syr Darya and Amu Darya waters for irrigation projects. By 2007 it had declined to 10% of its original size, splitting into four lakes: the North Aral Sea and the eastern and western basins of the once far larger South Aral Sea and one smaller lake between North and South Aral Sea. By 2009, the south-eastern lake had disappeared and the south-western lake retreated to a thin strip at the extreme west of the former southern sea.

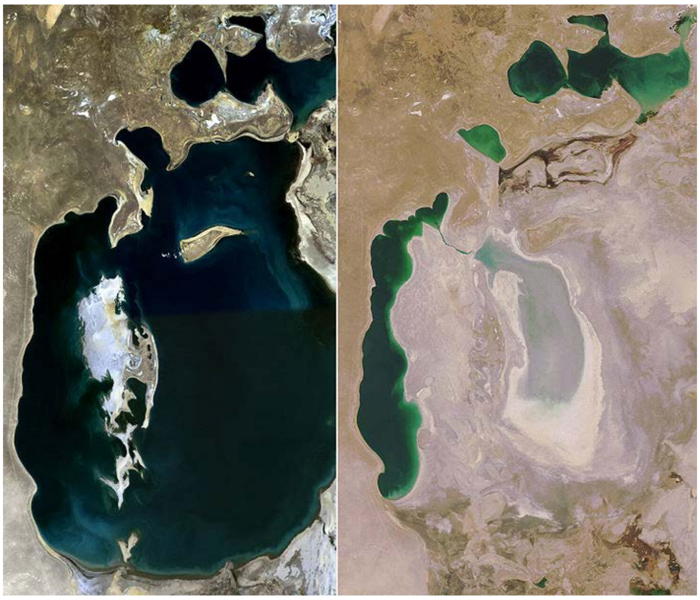

Photo 8-4: Aral Sea 1989 & 2008

Source: NASA / Wikipedia

The drying of the Aral Sea has severe adverse consequences, in particular because of the dispersion of salts and pollutants in the surrounding environment. Although a reserve of water for the Aral Sea is made in the Amu Darya management plans, the practice shows that this reserve has been used like a buffer to meteorological and hydrological uncertainties, resulting in significant deviations (positively or negatively) to the targets.

8.3 Hydrology: River Discharge Downstream of the Dam

Hydrology is a central issue of the study and needs to cover the following aspects: contribution of Tajikistan to the hydrology of the Amu Darya basin, effluents from Vakhsh, effects of the cascade (operational and planned), water requirements in the d/s area (including riparian countries), and effects of Rogun HPP.

8.3.1 Flow Pattern of Vakhsh River

Vakhsh is a very seasonal river, with a discharge maximum in July and a minimum in February, as can be seen from the following Figure. River flow is mainly influenced by snow melt, since a major part of the annual precipitation falls during the winter months, in higher areas as snow.

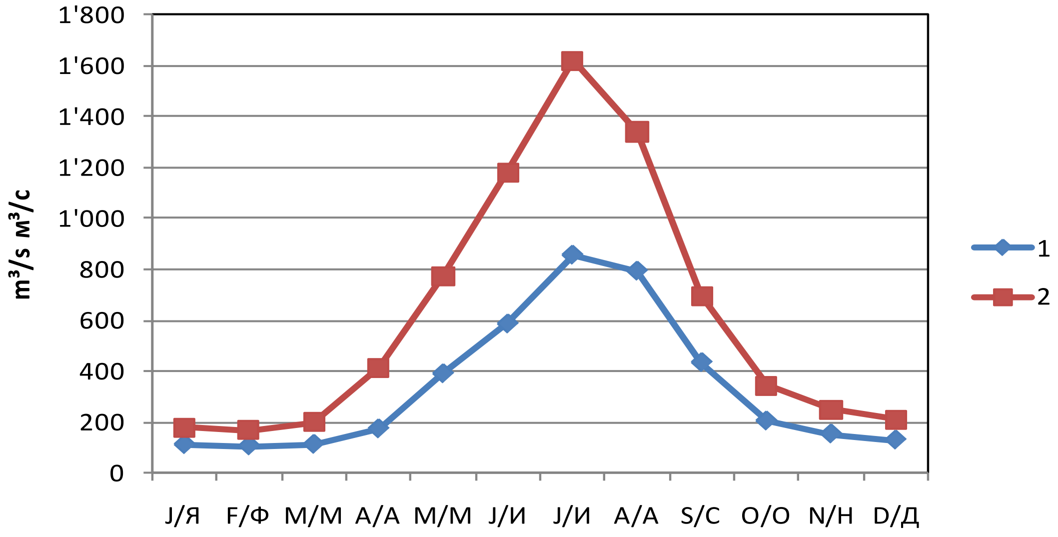

Figure 8-12: Monthly average flow of Vakhsh River

1 = Surkhob river (near Garm) 2 = Vakhsh river at Nurobod (Komsomolobod)

8.3.2 Effect of Nurek

One important question is whether Nurek dam had any influence on the downstream discharge pattern, and especially on the flow pattern of Amu Darya. This needs to be analysed based on existing information. A first evaluation was made and is described here; however, the points raised here need to be analysed in more detail the ESIA.

One first question is whether overall water availability was influenced. According to the available information, year to year overall flow is highly variable, but there is no trend visible; total flow of Amu Darya at the point where it leaves the mountains seems not to have changed (see Figure 8-3 in Annex 8).

The second question to be addressed is the seasonal distribution of river discharge. As can be seen from the following Figure, Nurek had the regulating effect on Vakhsh discharge downstream of the dam which would be expected for a storage dam: there was a marked shift from high flow season to low flow season.

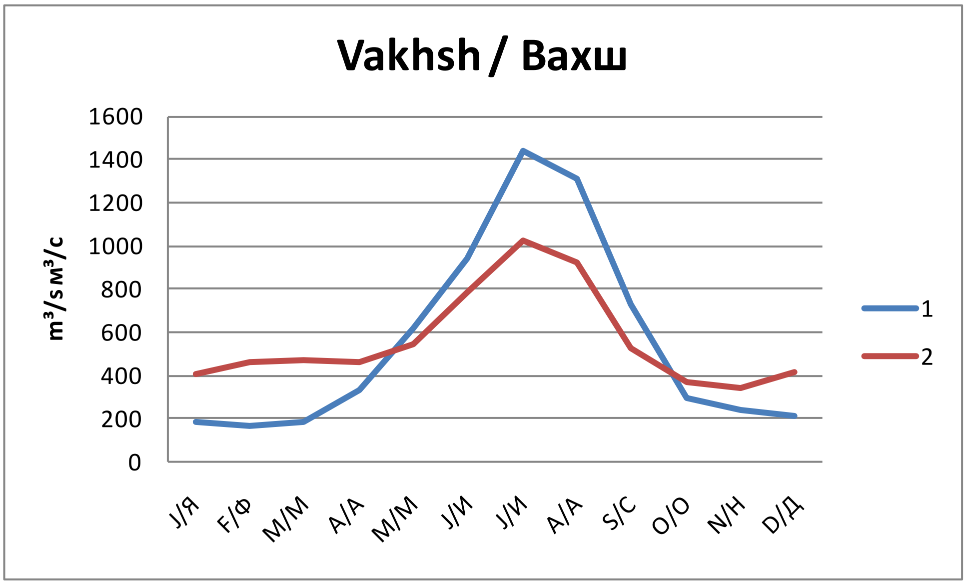

Figure 8-13: Effect of Nurek dam on Vakhsh discharge

Values for Vakhsh-Tigrovaya Balka station:
1 = without Nurek (1960-1962)
2 = with Nurek (1984-1990)

8.3.3 Effect of Irrigation

Irrigation upstream of Nurek - or of Rogun dam site, since there is no agriculture between Rogun and Nurek reservoir - is rather limited due to the limitations in availability of suitable land. Furthermore, water for these small scale irrigation is taken from tributaries of Vakhsh river and not directly from the river itself. Therefore, water used for this purpose is not evidenced by measuring the flow in the river.

The situation is different for the lower part of Vakhsh valley, where there are flat areas suitable for irrigated agriculture. In this part of the valley, 180’000 ha are irrigated. The irrigation water stems from the river (or, more precisely, from Nurek reservoir, 0.42 km³/year, and Baipaza reservoir, 0.8 km³/year). Since there is a gauging station immediately d/s of Nurek (Sariguzar) and one close to the confluence of Vakhsh with Pyanj, the difference in discharge between these two stations can be taken as the water used for irrigation (plus other uses, plus infiltration into ground water, minus inflow from different sources). Since there are no major tributaries to this part of Vakhsh this provides at least an estimate of water use (keeping in mind that some water is being abstracted directly from Nurek reservoir, and this is not measured in Sariguzar). This is shown in the following Figure (see also data in more detail in Annex 8).

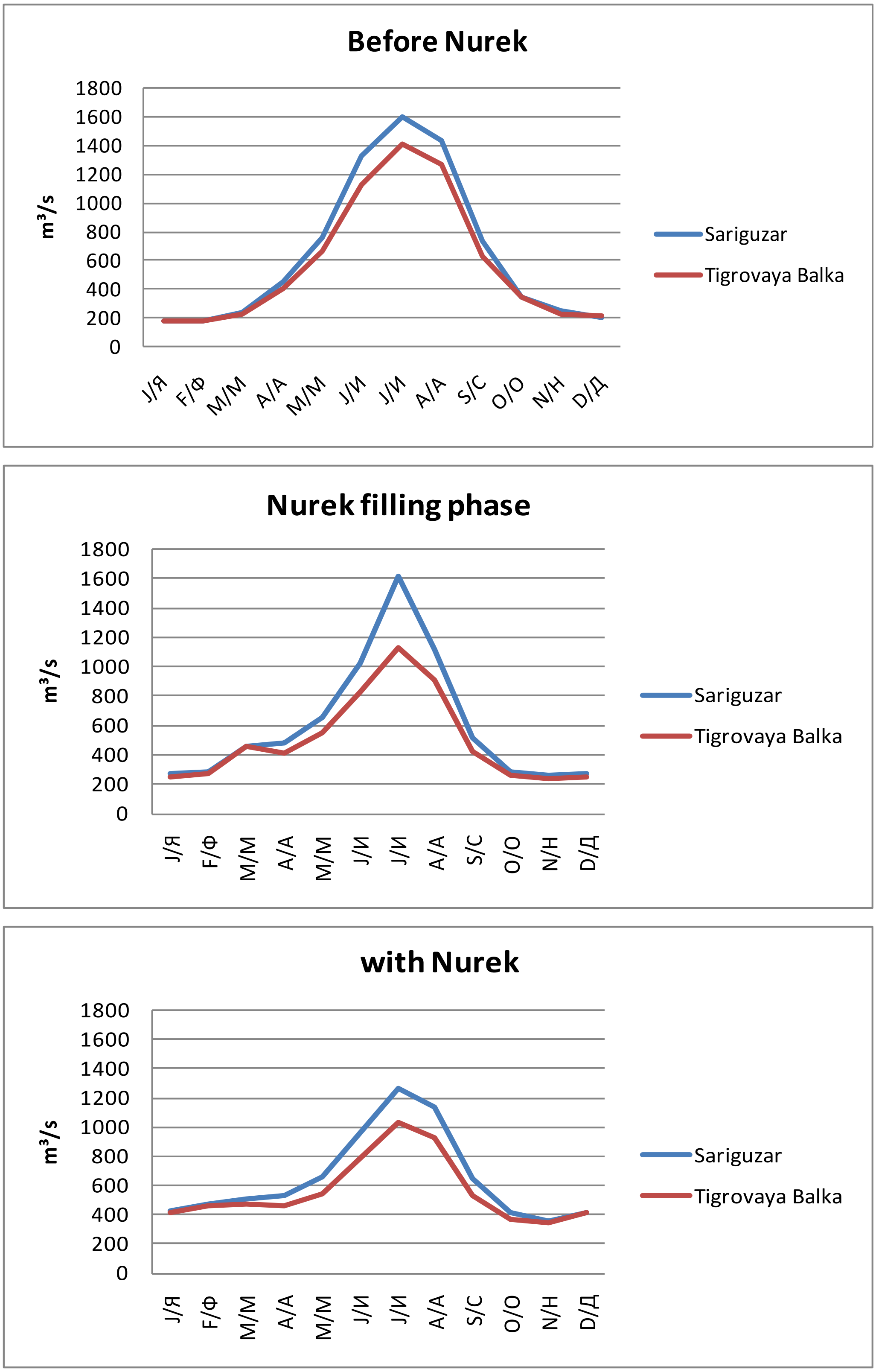

Figure 8-14: Effect of irrigation on Vakhsh river discharge

Note: the figure for Sariguzar, July (filling phase) needs to be checked, is probably too high

The Figure shows two things, namely:

- In summer, during the vegetation period, there is a marked reduction in river discharge between these two stations. This corresponds to the water needed for irrigation. However, flow in winter remains almost unchanged, which shows that there is no significant water abstraction during this period, but also no inflow of additional water.

- The effect of Nurek (difference between top and bottom graphs in the Figure confirms what was shown already in Figure 8-13: a reduction of flow in summer and an increase in winter, i.e. a shift from the high flow to the low flow season.

A next question is whether Nurek had and influence of water use for irrigation (whereby it has to be considered that a change in water use would not necessarily have had to do with Nurek, but could have happened independently of it). This is shown in the following Figure.

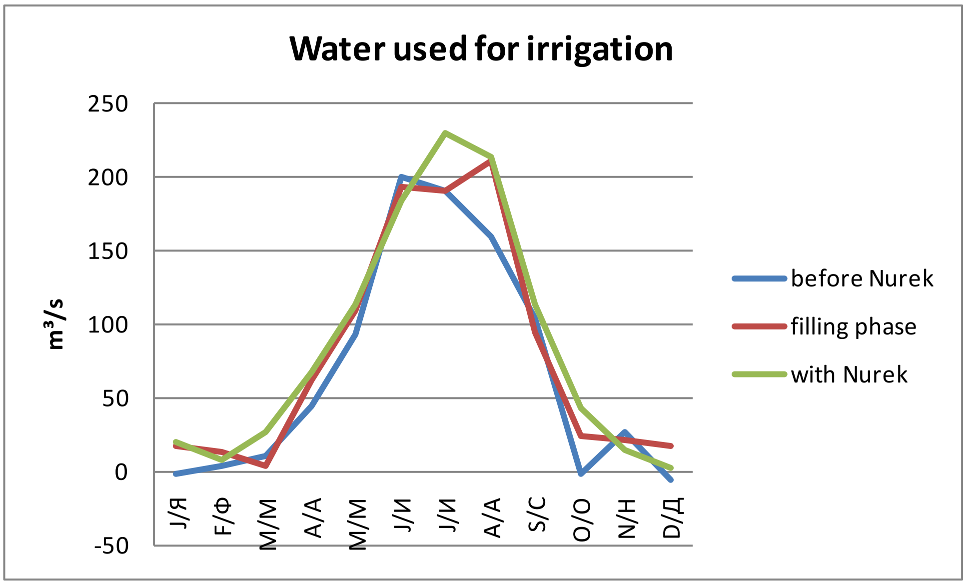

Figure 8-15: Water used for irrigation in the lower Vakhsh valley

The Figure compares data from three periods, namely:

- situation without Nurek (1960-62 and 1966-71)
- filling phase of Nurek reservoir (1972-83) and
- situation with Nurek (1984-90)

The Figure shows that there is no difference in water consumption. The values are close to zero in winter (October to March), when there is no plant growth, and reach about 200 m³/s in June to August. The fact that Nurek went into operation did not change the amount of water used for irrigation in the lower Vakhsh valley.

The next Figure shows the average yearly flow for these three periods.

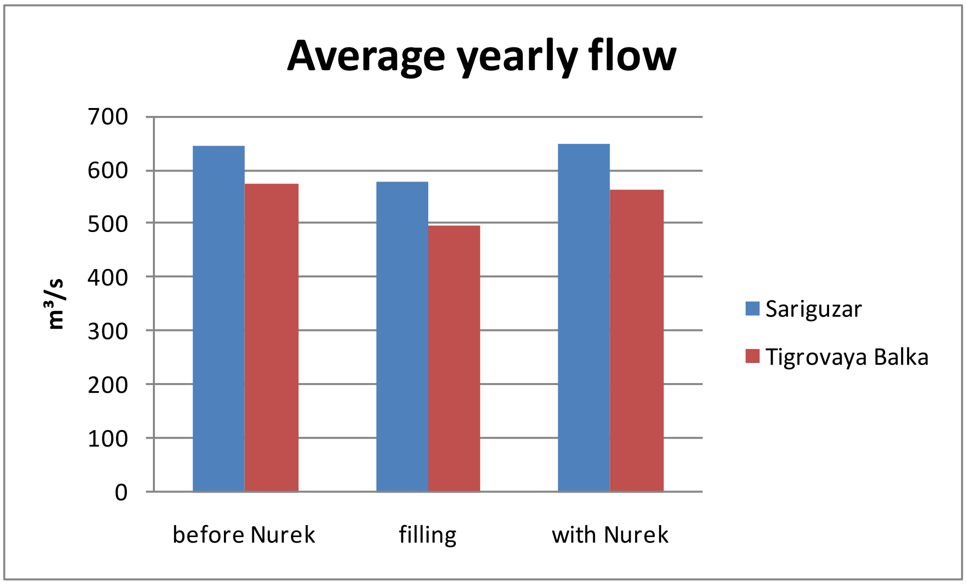

Figure 8-16: Average yearly flow of Vakhsh river

The Figure shows that average yearly flow before and with Nurek is almost exactly the same. However, during the filling phase, flow was reduced, and this reflects the amount of water that was required for filling the large reservoir.

It would be important to know how the situation has evolved since the independence of Tajikistan, and what the present situation is. However, so far the Consultant has not received any data for this period, and it is not possible to say right now if such data exist.

8.3.4 Combined Effect of Nurek Dam and Irrigation

The following Figure shows the situation with and without Nurek for three stations, namely:

- Komsomolobod (Novobod, Darband): in upper part of the future Rogun reservoir, not influenced neither by irrigation nor by Nurek dam, since these activities take place further downstream.
- Sariguzar: just d/s of Nurek dam site; influenced by Nurek, but not by irrigation in lower Vakhsh valley, since intake channels for irrigation are further downstream.
- Tigrovaya Balka: rather close to confluence of Vakhsh with Pyanj, downstream of intake channels for irrigation, therefore influenced by both Nurek and irrigation.

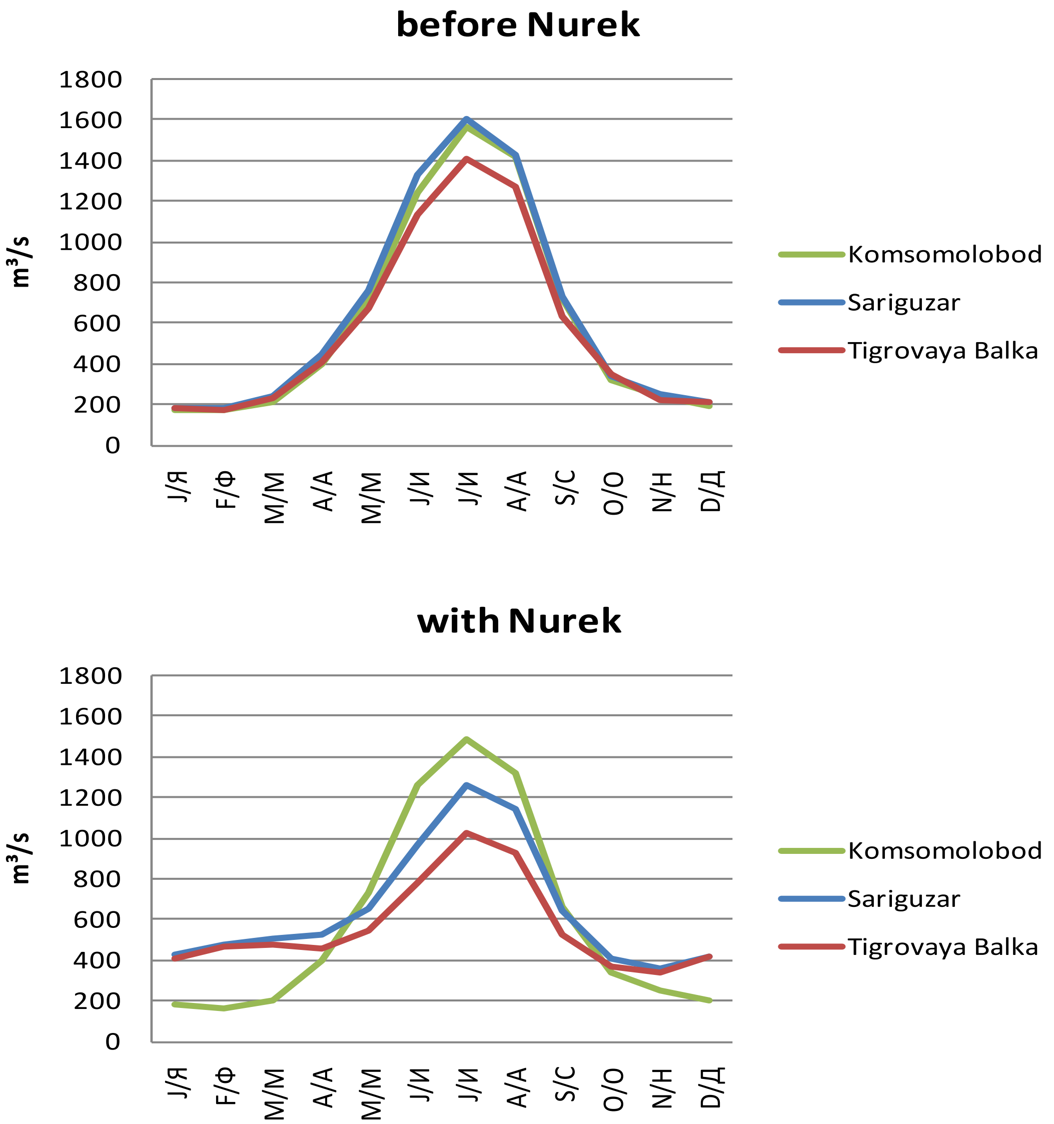

Figure 8-17: Effect of Nurek and irrigation on Vakhsh river

The Figure shows the following:

- Before Nurek, the two upper stations (Komsomolobod and Sariguzar) showed practically identical flow, indicating that between these two stations there is neither a major tributary nor a substantial water withdrawal The difference in summer between these two stations and Tigrovaya Balka (zero in winter, up to 200 m³/s in summer) indicates water use for irrigation.
- With Nurek, there is a marked difference between Komsomolobod (not influenced) and Sariguzar (influenced by Nurek): distinctive shift from summer (high flow season) to winter (low flow season). This is the effect of the regulating capacity of Nurek, which stores water in summer for producing electricity in winter.

- In this situation, the difference between Sariguzar and Tigrovaya Balka remains practically identical: zero in winter, about 200 m³/s in summer): water needed for irrigation remained practically the same.

Given the short periods available for this comparison, some natural differences have to be expected which have nothing to do with the project. This is shown in the following Figure for Komsomolobod, a station upstream of Nurek and therefore not influenced by it. The values are quite similar, the only noticeable difference is the peak (July) value, which is about 100 m³/s lower for the period “with Nurek” as compared to the two other periods. This, however, is still well within natural fluctuations and has nothing to do with Nurek or other types of human interference.

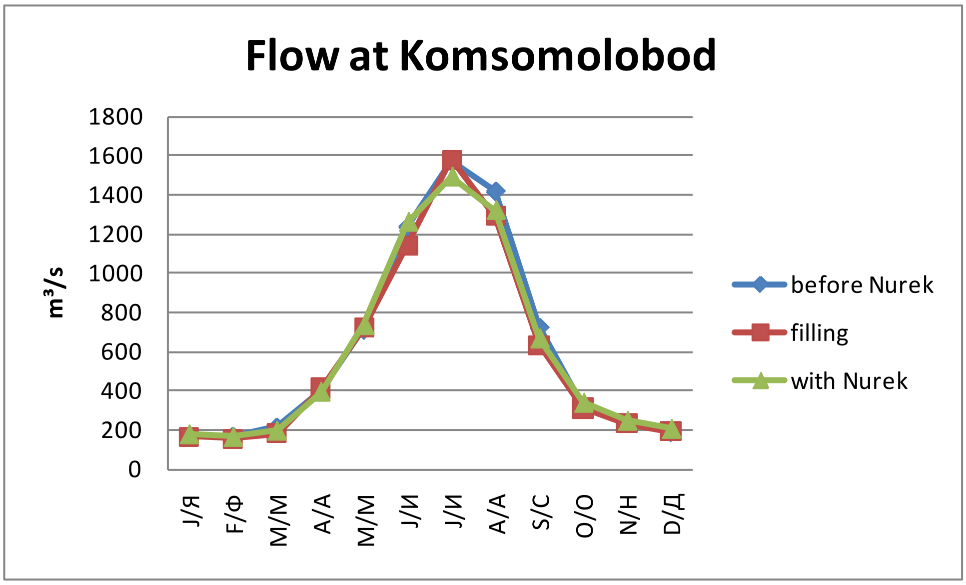

Figure 8-18: Comparison of flow data for a station not influenced by Nurek

8.3.5 Effect on Amu Darya

It remains to be seen to what extent this effect of Nurek dam and reservoir manifested itself in Amu Darya. There is no gauging station on the Amu Darya itself on the territory of Tajikistan, from which data could have been used for this analysis. One such station is presently under construction, and it will measure river flow at the point where Amu Darya leaves the territory of Tajikistan; this station will play an important role for monitoring water flow, and with it effects of water use in Tajikistan, but for the time being other data have to be used.

For the following analysis, data from three stations were used, namely:

- No. 9: Pyanj-Nizhni Pyanj, close to the confluence with Vakhsh;
- No. 48: Vakhsh-Tigrovaya Balka, close to confluence with Pyanj;
- No. 64: Kafirnigan-Tartki; this is the only major tributary to Amu Darya from Tajik territory below the Vakhsh-Pyanj confluence.

The sum of discharge of these three rivers provides a good estimate of the flow of Amu Darya before it crosses the Tajik border.

The amount of data available for the analysis is limited. The following data have been used:

- Situation without Nurek: Vakhsh 1960-1962; Pyanj 1965-1967; Kafirnigan 1960-1967;
- Situation with Nurek: 1984-1990 for all three stations.

The following Figures show the average values of the available data as listed above, **cumulated for the three stations**.

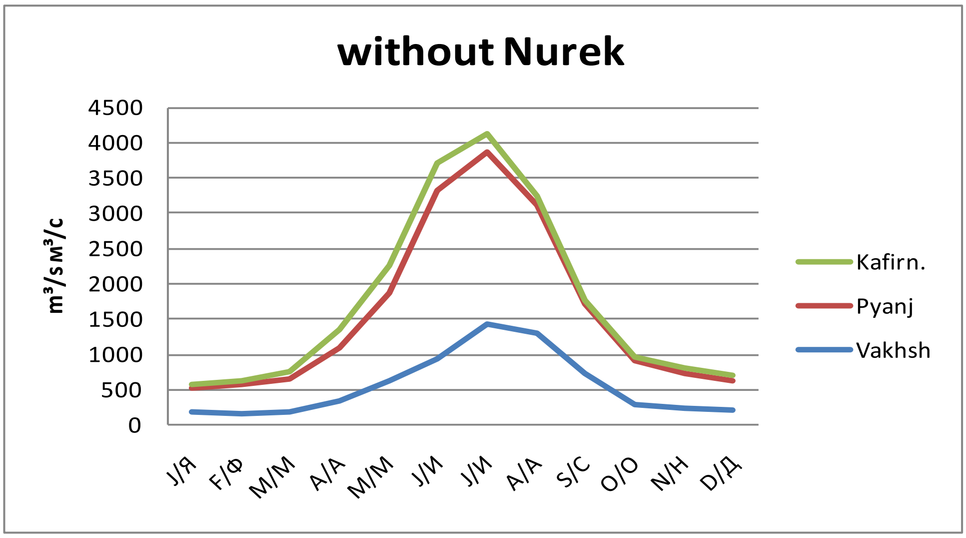

Figure 8-19: Amu Darya flow before the construction of Nurek dam

Total minimum flow (January) = 585 m³/s
Total maximum flow (July) = 4117 m³/s
Yearly average for the period = 1743 m³/s

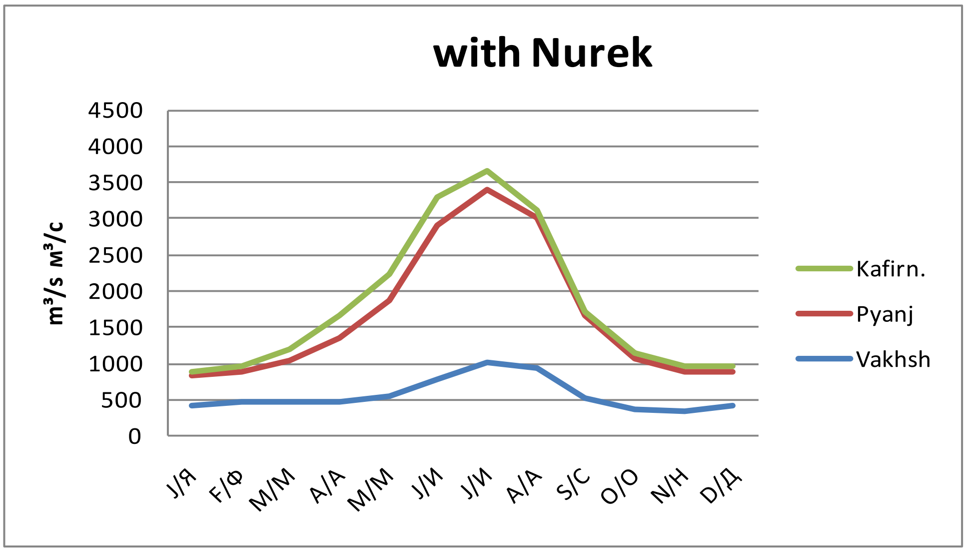

Figure 8-20: Amu Darya flow after the construction of Nurek dam

Total minimum flow (January) = 893 m³/s
Total maximum flow (July) = 3657 m³/s
Yearly average for the period = 1812 m³/s

The two Figures above show, first of all, that the lion’s share of Amu Darya flows (60%) stems from Pyanj river; Vakhsh contributes 31%, Kafirnigan 9%. Basically, the same effect of Nurek can be seen in Amu Darya as was described for Vakhsh: a shift from high flow season (summer) to low flow season. This is evidenced in the Figure below which directly compares flow in Amu Darya before and after construction of Nurek dam.

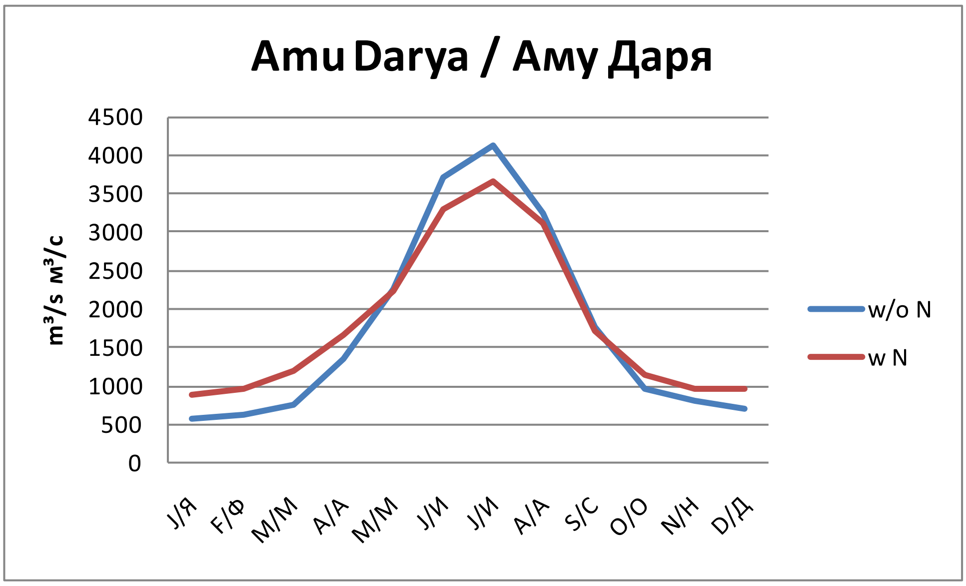

Figure 8-21: Comparison of Amu Darya flow without and with Nurek dam

w/o N = without Nurek
w N = with Nurek

While Nurek influenced the seasonal distribution of runoff, the available data do not show any effect of the dam on average yearly discharge, as is shown in the following Figure.

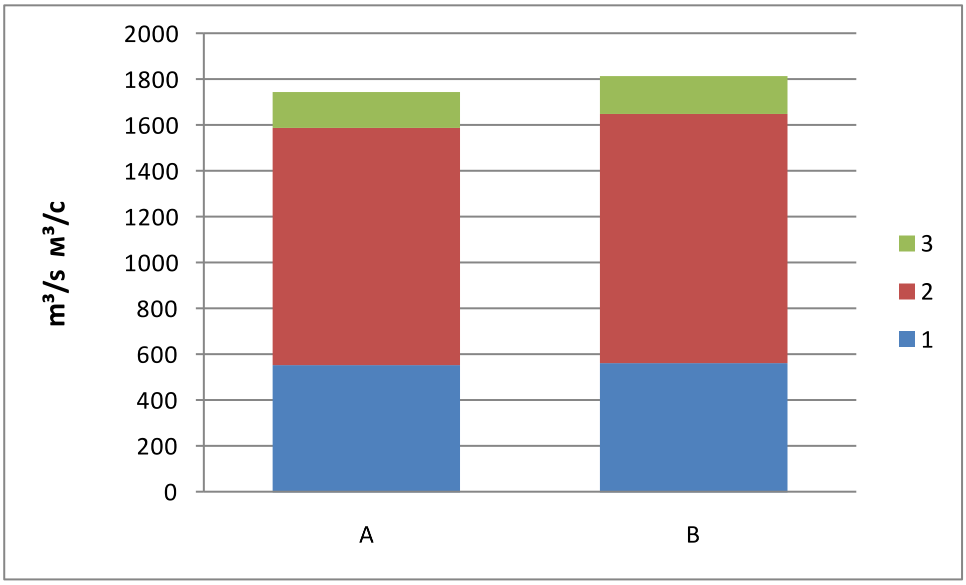

Figure 8-22: Average yearly flow in Amu Darya without and with Nurek dam

A = without Nurek
B = with Nurek
1= Vakhsh
2 = Pyanj
3 = Kafirnigan

The slightly higher runoff in the 1980ies (with Nurek) as compared to the 1960ies (before the construction of Nurek) is well within normal variation. The percentage of the three tributaries remained practically unchanged.

8.4 Effect of Rogun

8.4.1 Next Steps

The analysis of the data available so far has shown the effect of Nurek dam and the irrigation on the flow of Vakhsh river, and therefore on Amu Darya.

The further analysis, for the ESIA, needs to concentrate on two issues, namely:

- Evolution of the situation since independence of Tajikistan; Nurek is still in place, and presumably operating in a similar manner as before. However, it is not known if water requirements for irrigation have changed. The question here is whether it will be possible to get any reliable data for this period (1991-2010).
- Effect of Rogun HPP; this will have to be superimposed on the available data in order to verify if, and if yes to what extent (direction and amount) Rogun HPP will influence the flow pattern in Vakhsh and Amu Darya.

This latter step will be made once operation scenarios will have been defined with the TEAS Consultant.

8.4.2 Importance

It was shown that Nurek had two effects on Amu Darya flows, effects which are generally associated with large storage reservoirs used for energy production, namely:

- a reduction in river discharge during the summer (high flow season), and

- an increase in river discharge in winter (low flow season).

This is a logical effect of a storage reservoir aiming at accumulating water during the high flow season for using it for energy production in the low flow season.

In relation to Rogun, there is obviously the question whether its presence would increase this effect, causing an additional change in the same direction, i.e. a further decrease in summer flows and a corresponding increase in winter flow. Assuming the same effect of Rogun as Nurek had, this could mean a further reduction in peak flow in June and July by about another 400 m^3/s. This, obviously, would mean a reduction of water available for irrigation in the downstream area of Amu Darya, i.e. in the riparian countries.

However, this would be a far too simplistic way of looking at the situation, and one which is not necessarily anywhere near the true situation. It can easily be seen, e.g., that the presence of Rogun HPP, in addition to Nurek, would roughly double electricity production even if Rogun reservoir were operated in a way as not to change at all the flow situation downstream of Nurek. Other scenarios are possible. So e.g. in a dry summer the presence of large storage capacity upstream might be advantageous for the irrigation schemes in the downstream area, provided regulation schemes and agreements between riparian states were in place to allocate water accordingly.

In order to be able to assess this rather complex situation in a meaningful way, a hydraulic modelling will be carried out for the entire cascade. The definition of this hydraulic model, to be developed and applied by TEAS, was one of the main discussion points during the visit of the WB delegation and the POE in August 2011. A short description of the work foreseen is provided in Section 8.7.

8.5 Residual Flow

8.5.1 Reason for Residual Flow

Rogun HPP will be operated as a peaking power plant, for producing energy mainly during peak demand hours; details of this operation pattern remain to be defined. However, there is certainly the possibility to close the turbines down completely, at least for some hours in times when the reservoir is near its FSL, for longer periods, if required, when it is close to MOL. This would mean that there can be periods with zero flow in the river below the dam. Therefore it is necessary to evaluate the situation and to define the need for a residual flow.

A residual (ecological, minimum) flow is defined as the minimum amount of water which needs to be kept flowing at all times - and especially during times when the turbines are shut down - in order to guarantee a minimum of water in the river on a permanent basis.

The main purpose of defining and maintaining a minimum flow is usually one or both of the two following:

- to maintain the affected part of the river as a habitat, mainly for fish, but also for other aquatic life; and/or
- to guarantee water availability on a permanent basis for water users along the affected stretch of river; this concerns mainly water needs for irrigation or

drinking water supply, or for maintaining a sufficient dilution of waste water being discharged into the river.

8.5.2 Methods for Determination of Residual Flow

Some countries have a legal basis for defining this residual flow, as e.g. Switzerland (see Annex 8.4). Tajikistan as yet does not have such a legislation. However, there is a regulation stemming from the former USSR (1986), which in such cases can still be applied (USSR 1986: Sanitary rules for design, construction and operation of reservoirs. Agreed, August 12, 1986. # DP-3979-1; Approved, July 1, 1985. # 3907-85. Source: http://www.cih.ru/s2/330.html).

Section 4 of this regulation deals with requirements for reservoir operation. It makes reference to water releases from a reservoir to the downstream area, putting emphasis on sanitary and water quality issues, as well as water use (e.g. as drinking water) in the downstream area. No rule is provided for the determination of a residual flow, and no mention is made of required conditions for fish populations or aquatic ecology. The only quantitative indication is that in the case of "complex reservoirs", minimum flow should correspond at least to the value of 95% availability (which would correspond to a Q_{347} as mentioned above), and this again for sanitary reasons.

Values that would be reached according to different methods can be compared.

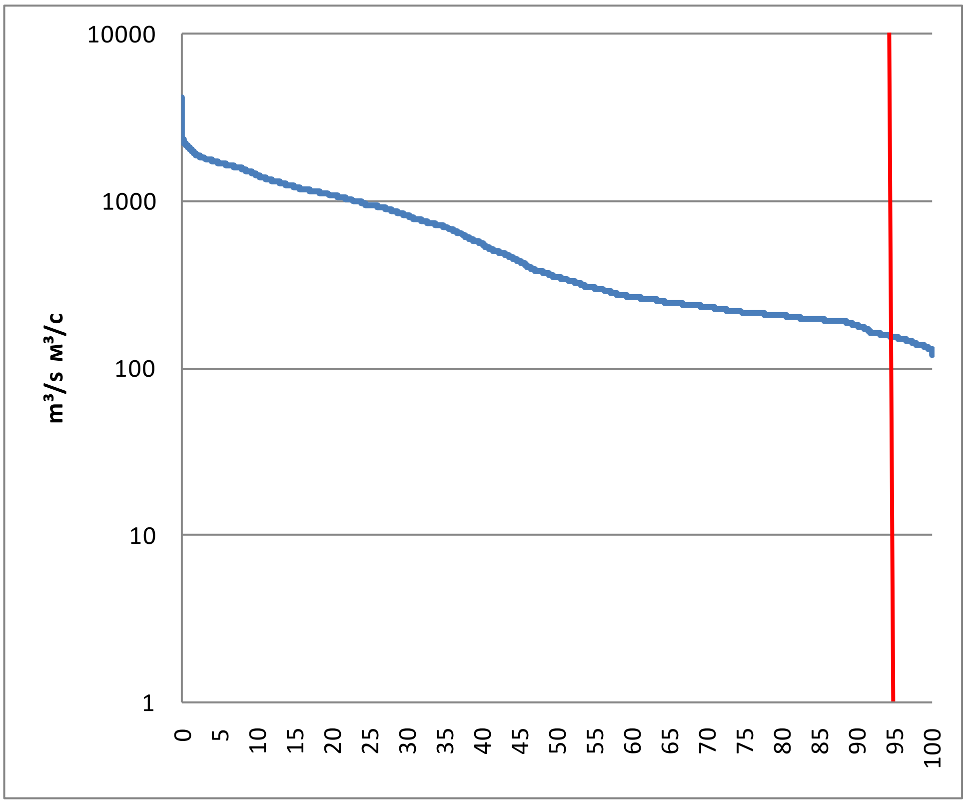

Figure 8-23: Frequency distribution of runoff for Vakhsh river

Darband, 1949-1967

One value often used as a reference value is the runoff which is reached or exceeded during 95% of the time (which corresponds to the value Q_{347}, i.e. the flow which is exceeded on 347 days per year). This value, marked in the Figure above, is 154 m^3/s in the case of Rogun. According to rules mentioned in Annex 8.4, this could mean that a residual flow of 154 m^3/s would have to be maintained (according to UK legislation), or 10 m^3/s (according to Swiss legislation), in both cases with a possibility for modification due to specific conditions.

In the absence of specific legislation in Tajikistan for residual flows, this question will have to be addressed on the basis of an evaluation of ecological needs in the reach between Rogun HPP and Nurek reservoir.

8.5.3 Considerations and Conclusions

In the case of Rogun, a certain number of specific conditions has to be considered, namely:

- The affected stretch of river, where discharge could temporarily be reduced to 0, is very short, it is only the part between Rogun dam and the upper end of Nurek reservoir, a total of approximately 10 km. Further downstream, river discharge is regulated by Nurek, Rogun has no direct effect on that.
- There are no settlements, i.e. no water users, along this affected part of the river.
- What the importance of this river stretch is for fish is presently under investigation. In any case, even if there were fish migrations from Nurek reservoir upstream, these would be blocked by Rogun dam.
- Immediately downstream of the dam there is a tributary which brings a certain amount of water (there do not seem to be any data on its discharge); this means that even in the absence of a residual flow from the dam, this part of the river will never be completely dry.
- One additional condition has to be taken into consideration: there is a plan for an additional HPP, Shurob, between Rogun dam and Nurek reservoir. If this will actually be implemented, there might be no need for a residual flow. The geometry of this plant (FSL, distance to Nurek reservoir) still needs to be clarified. The situation for this case, based on presently available information, is shown below.

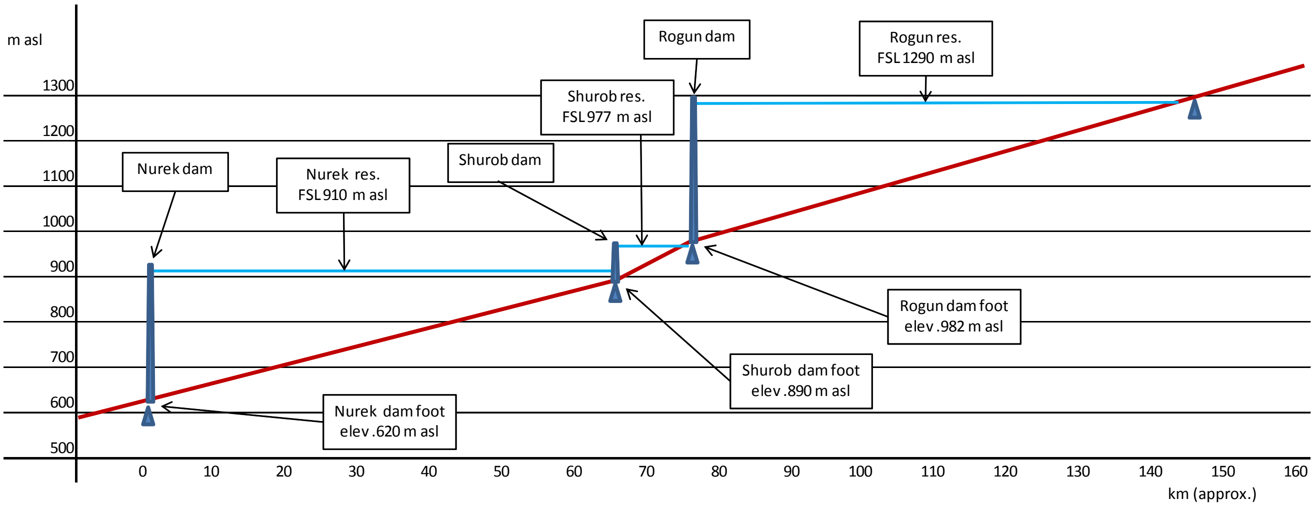

Figure 8-24: Cascade in upper Vakhsh river

Table 8-2: Cascade in upper Vakhsh river

	Unit	Nurek	Shurob*	Rogun
River bed elevation at dam site	m asl	620	890	982
Dam crest elevation	m asl	920	983	1300
Reservoir FSL	m asl	910	977	1290
Dam height	m	300	93	335

* Data for Shurob have to be seen as provisional, not confirmed

If Shurob would be implemented as indicated in the Figure and Table above, the situation would be as follows:

- Shurob dam site is immediately at the upper end of Nurek reservoir (about 65 km u/s of Nurek dam).
- When Nurek reservoir is full (FSL 910 m asl), its water reaches the water outlet of Shurob HPP.
- When the water level of Nurek is lower, there would still be water flowing between Shurob and Nurek reservoir, since Shurob will be operated as ROR, with very little regulating capacity.
- Shuorb reservoir has an FSL of 977 m asl, and an MOL of 973 m asl, while the river bed elevation at Rogun dam site is 982 m asl. This means that Shurob reservoir would almost reach Rogun dam; at most, a few 100 m would be between the foot of the dam and Shurob reservoir, in an area where Vakhsh river is highly disturbed by construction and operation of Rogun in any case.

This would mean that with Shurob in place there would be as good as no part of the river left which could run dry in an extreme case. In this situation providing a residual flow would not be required.

8.5.4 Recommendations

As has been said, the part of the river which would benefit from a residual flow presents the following main characteristics:

- It is only a short stretch of about 15 km between Rogun dam and Nurek reservoir.
- There is a small tributary immediately below Rogun dam with a continuous, albeit small flow. This means that the river bed below Rogun dam will never be completely dry.
- The entire area is not inhabited, therefore there are no water users and no input of waste water, no need for a sanitary flow.
- The area has a very limited importance for fish populations and fisheries (see Chapter on Aquatic Fauna).
- There is a project for an additional HPP, Shurob, which would basically cover this entire area.

Given this situation, it is recommended to use the following cases for the hydraulic modelling:

- Residual flow of 150 m^3/s: given the low importance of the affected part of the river in terms of ecology and water use, this value is probably too high, but it would be according to the Q_{347} requirement.
- Residual flow of 10 m^3/s: this is a value defined and legally sanctioned in Switzerland, and it was done mainly for conservation of salmonid fish species in mountain streams. For this reason it is seen as appropriate for the case of Vakhsh at this place, which is a mountain river inhabited by (albeit few) salmonid fish.
- Residual flow of zero: this could be justified by the short part of river affected, the low ecological value, and certainly for the case that Shuorb HPP would be built.

Application of these three values on the model would then show what the consequences especially in terms of loss in energy production would be, and this can then be used for the final definition of the amount of residual flow.

It has to be stated clearly that a residual flow defined for Rogun will not influence in any way the river discharge pattern downstream of Nurek, since the regulating capacity of Nurek is large and the discharge in Vakhsh d/s of Nurek HPP is determined entirely by the operation of this latter.

8.6 Water Quality

8.6.1 Reservoir Stratification

Large and deep reservoirs in temperate climates, like natural lakes, usually show a thermal stratification during summer, when water temperature at the surface is rather high, while water in greater depth is much colder.

An empirical dependence of reservoir stratification on residence time (τ) to the maximum temperature difference between the surface and hypolimnion (i.e. water in the deeper areas of the reservoir) was found by Straskraba and Mauersberg (1988; cited after EAWAG 2006) for several reservoirs in the Czech Republic, approximated by the equation:

$\Delta T_{0\text{-}30} = 20\ (1\text{-}\exp\ (-0.0126 * \tau))$

whereby $\Delta T_{0\text{-}30}$ is the difference in water temperature between the surface and a depth of 30 m, and τ is the residence time of the water in the reservoir.

According to this formula, with a residence time (τ) of about 252 days, the temperature difference between surface and hypolimnion would correspond to a maximum of about 19°C. This should not be taken as an accurate value, but rather as an estimate of the upper limit. Nevertheless, this important difference in temperature would indicate a stable thermal stratification. Under the given climatic conditions (hot summers, cold winters) however, this stratification will not persist, there will be a circulation within the reservoir twice a year, in autumn and early winter, when the water at the surface gets cooler, and in spring, when it gets warmer again.

8.6.2 Oxygen and GHG Emissions

Reservoir stratification is also important with respect to oxygen content of the water. During a stable thermal stratification in summer, oxygen in deeper layers can be depleted if large amounts of organic matter has to be broken down. In the case of a reservoir, this can be the case under two conditions, namely:

- after first filling, if large amounts of biomass (vegetation) was submerged and is now being broken down, and
- in cases where eutrophication of the reservoir happens, i.e. when large amounts of nutrients are being brought into the reservoir, which lead to a high plant (algae) productivity close to the surface, where there is enough light for photosynthesis.

The first condition (submergence of biomass) can lead to anoxic conditions in the reservoir, and this in turn will lead to methane (CH_4) production; methane is a very powerful greenhouse gas (GHG). This is the case mainly in tropical reservoirs, where often very large amounts of biomass are submerged. The risk for such a development in Rogun is calculated with a simple model in the following Table.

Table 8-3: Oxygen requirements in Rogun reservoir

	Parameter	Unit	Rogun
1	Biomass total (soft only)	t	170'000.00
2	Reservoir area	ha	17'000.00
3	Biomass average (soft biomass only)	t/ha	10.00
4	Mean annual river discharge	m³/s	631.00
5	Water in res., total volume	mio m³	13'300.00
6	Annual inflow	mio m³	19'876.50
7	Oxygen in inflow water	mg/l	8.00
8	Oxygen per m³	g/m³	8.00
9	Oxygen total at first filling	t	106'400.00
10	Oxygen total in annual inflow	t	159'012.00
11	Oxygen demand /t biomass	t	1.07
12	Oxygen demand total	t	181'900.00

13	O2 balance 1: O2(1st filling) - O2 demand	t	-75'500.00
14	O2 balance 2: O2(annual inflow) - O2 demand	t	-22'888.00
15	O2 balance 1: % of O2 required available 1st filling	%	58.49
16	O2 balance 2: % of O2 required available yearly	%	87.42

Explanations:
1 = total soft biomass (leaves, twigs) in the reservoir area to be submerged at first filling
2 = reservoir area in ha
3 = soft biomass per ha (estimated in comparison with other sites with similar vegetation
4 = mean annual river discharge at dam site
5 = total reservoir volume at FSL
6 = total amount of water flowing into the reservoir per year
7 = mean concentration of oxygen in inflowing water
8 = total oxygen per m^3 of inflowing water
9 = total amount of oxygen in amount of water required for filling the reservoir
10 = total amount of oxygen flowing into the reservoir per year
11 = amount of oxygen required to decompose 1 to of biomass
12 = total amount of oxygen required to decompose the submerged soft biomass
13 = O2 balance at first filling (meaning that an additional 75’500 t would be required for decomposing all the soft biomass after first filling)
14 = O2 balance after one year (meaning that an additional 22’900 t would be required for decomposing all the soft biomass within one year)
15 = the water after first filling of the reservoir contains 58% of the oxygen required for breaking down all the soft biomass submerged
16 = the water flowing into the reservoir in one year contains 87% of the oxygen required for breaking down all the soft biomass submerged
For additional explanations of the model see Zwahlen (2003)

The result of this calculation shows that there would be an oxygen deficit. However, the following conditions have to be considered in the case of Rogun:

- For the calculation, an oxygen content of the water of 8 mg/l was assumed. Since the water in the inflowing rivers is rather cold and, due to the turbulence in the rives, saturated with oxygen, this content is probably rather around 10 mg/l; if this value is taken for the calculation, O_2 content in the water flowing into the reservoir would be sufficient for breaking down all the organic matter.
- The inflowing water is rather cold (stemming from snow melt), and this means that breakdown of biomass will be slow (much slower as would be the case under tropical conditions).
- The reservoir will not be filled within one year, but the filling process will take a number of years, during which the reservoir will increase in steps (see Figure 18-1 in Annex 3). This also means that the biomass will be submerged (and decomposed) during this long period.

The risk of reservoir eutrophication at alter stages is not very high either. There is little agriculture upstream of the reservoir, and therefore little input of fertilizers. There are also no large settlements with an important input of waste water, which could lead to eutrophication of the reservoir.

8.6.3 Conclusions

The risk of deteriorating water quality, and especially the risk of anoxic conditions in the deeper layers of the reservoir, which could lead to considerable greenhouse gas emissions, is very low. Still, a monitoring of water quality should be carried out; a program will be proposed in the EMP in the ESIA Report. Likewise, waste water from settlements should be treated in wastewater treatment plants before being reverted to the river; such a wastewater treatment plant is under construction in Dangara, the new Hukumat centre which will replace Novobod.

8.7 Next Steps

8.7.1 General Approach

The information received during the screening phase on (i) the operation of Nurek dam and Vakhsh cascade and (ii) the allocation of water in the Amu Darya basin (under the coordination of ICWC) gave a good understanding of the water management challenges associated to the construction of Rogun Dam.

In the second phase of the assignment, i.e. the preparation of the ESIA Report, a detailed analysis of the information will be carried out in order to understand the way Rogun reservoir is expected to be filled and later operated, and the possible impacts of the filling and operation of Rogun on downstream water discharge and water uses. In this respect, simulation results from TEAS will be used; based on available hydrological data, this will show:

1. how Rogun reservoir will be filled without affecting downstream water uses and water rights (in Tajikistan, Uzbekistan & Turkmenistan), and without affecting the electricity production of Vakhsh cascade;
2. how Rogun operation (after the reservoir is filled) could be operated in a way that benefits (or at least does not adversely impact) downstream uses.

Detailed analysis, interpretation and discussion of these issues, related to the hydrological situation downstream of Rogun dam, will be one of the central points of the EISA. An outline of how to approach this subject is provided in the following section.

8.7.2 Hydraulic Modelling of Vakhsh Cascade

8.7.2.1 Input from ESIA Consultant

In a first step, the ESIA Consultant developed a number of criteria to be used for the hydraulic model. These were as follows:

Prevailing situation:

The three drivers of water management in Amu Darya basin are:

- the meteorological conditions (direct precipitations and seasonal snow melting) which determine the runoff of rivers and thereby the availability of water resources;
- agreement on water distribution between the countries of the Amu Darya basin (Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan), approved by the MOM of the Scientific-Technical Council Ministry of Water Industry of the USSR, No. 566, dated September 10, 1987, Moscow (hereunder referred to as Protocol No. 566) subsequently acknowledged by the Nukus Declaration and presently regulated by BVO "Amu Darya" under coordination of the Interstate Coordination Water Industry Committee (ICWIC). Although Afghanistan is not

a member of ICWIC, by this document (Protocol No. 566) the amount of water allocated to it is determined as 2.1 km³/year.

- the satisfaction of water demand at each country level, by sub-allocating to water users the volumes of water allocated to the country by BVO.

Meteorological conditions are monitored by the national hydrometeorological services (Gidromet) which share information on the basis of specific interstate agreements. Snow stocks are subject to a specific monitoring (by plane and field investigations) and results are used to establish, at the end of each winter, a prognosis on the volumes of water that will result from snow melting.

In 1995, the Central Asian states adopted the Nukus Declaration which stipulates "We agree that the Central Asian states acknowledge the agreements, contracts and other legal texts signed and enacted earlier, regulating their relationship on water resources in the Aral basin, and steadily preform them".

The only document regulating relations between the states of Central Asia on water resources in the Amu Darya basin is Protocol No. 566, which was adopted by the Nukus Declaration as the fundamental document for this interstate distribution. This document defines the limits of water supply to each country as follows.

Table 8-4: Allocation of Amu Darya water resources by country

Country	billion m³	%
Kyrgyzstan	0.40	0.60
Tajikistan	9.50	15.40
Turkmenistan	22.00	35.80
Uzbekistan	29.60	48.20
Total	61.50	100.00

Note: this does not include the use of water resources by Afghanistan (2.1 billion m³/year), regulating releases to the Amu Darya river (3.15 billion m³/y, and losses form rivers and reservoirs (3.85 billion m³/y).

Attribution of water was done based on 50% flow probabilty of the Amu Darya river, i.e. on average annual flow. Since actual water availability changes from year to year, the ICWIC of the Central Asian countries at its annual meeting defines yearly water quota of each state, differentiating between growing and non-growing season. The control of compliance with these limits is carried out by the Basin Water Organisation (BVO) of Amu Darya. This means that actual yearly amounts allocated by ICWIC differ somewhat from those defined in Protocol No. 566. The amounts of water allocated to each state for the period of 1992 to 2010 are freely accessibly on the internet (http://www.cawater-info.net/amudarya/index.htm). The data provided there show that during this period, ICWIC states on average used less water than was allocated to them (see following Table).

Table 8-5: Water allocation and use in BVO countries 1992 - 2010

	Tajikistan	Kyrgyzstan	Turkmenistan	Uzbekistan	Aral Sea
Limits as per Protocol No. 566 (Mm³)	9'500	400	22'000	29'600	3'130
Average volume allocated by ICWIC (Mm³)	8’845	216	20’185	21’378	6’851
Actually used volume (Mm³)	7’274	8	18’792	20’318	9’043
Actually used volume (% of ICWIC allocation)	82.2	3.9	93.1	95.0	132.0
Actually used volume (% of Prot. No. 566 allocation)	76.6	2.0	85.4	68.6	287

This table shows that Tajikistan, in average and over the 1992-2010 period, did not use 1.5 km³ of the water it was allocated by ICWIC annually. If the values defined by Protocol No. 566 are taken as a basis, then the annual amount not used by Tajikistan is 2.2 km³/year. It should be mentioned that the yearly amount allocated to Tajikistan defined by ICWIC over the last 5 to 6 years was 9.5 km³/year, which is in compliance with Protocol No. 566. The actual volume of water unused by Tajikistan every year varies, mainly because of uncertainties on snow stock estimates which result in differences between allocated volumes and available volumes.

It is essential that within the framework of Rogun HPP, Tajikistan never uses more than the volume allocated to it by Protocol No. 566.

Filling of Rogun Reservoir

The result of the modelling should demonstrate how Rogun reservoir can be filled, taking into account the following objectives:

- without exceeding the water rights of Tajikistan set by Protocol No. 566, in order not to affect downstream water users outside Tajikistan;
- without affecting downstream water users within Tajikistan: irrigation needs and environmental needs (Tigrovaya Balka zone needs + the 100m³/s sanitary discharge);
- without affecting the production of electricity by Nurek HPP.

This demonstration should be based on simulations of the operation of Vakhsh cascade (including the operation of Nurek reservoir and filling of Rogun reservoir) based on hydrological and BVO data from the 1992-2010 period.

All data for the above calculations are available, except from the environmental needs for Tigrovaya Balka, which will be assessed by the ESIA team after the flood period (in September). This should not prevent the simulations to start, since the impact of Rogun HPP filling on Tigrovaya Balka area will be derived from the results of these simulations.

Presently, the need for an ecological minimum discharge between Rogun HPP and Nurek reservoir is not confirmed. The risk of rapid discharge variations (for example for peak production) and their possible impact on river banks stability is a stronger concern than the preservation of the existing river habitat which is not unique and will in any case be isolated from the upper Vakhsh river. An additional question is the Shurob HPP between Rogun and Nurek reservoir; available (but so far not yet confirmed) information indicates that this might make an ecological flow obsolete, since its reservoir might actually reach up to the dam of Rogun. Therefore, rather than imposing ecological requirements that might later be deemed unnecessary, we expect the simulations to show in a first stage how Rogun will be operated.

Operation of Rogun HPP (after the filling period)

The filling of Rogun reservoir will take several years, and will allow for inter-annual regulation of Vakhsh river (Nurek only allows for inter-seasonal regulation).

The long term operation of Rogun HPP and reservoir will be driven by the following parameters:

- electricity demand evolution
- water regulation demand
- possible evolution of the BVO organization and water allocation rules.

In this context, the energy, irrigation and intermediate scenarios that were used in previous studies are obsolete hypotheses and should not be considered anymore, because they are not supported by actual needs and might result in non-compliance with the BVO obligations.

It is therefore recommend that long term simulations use the 1992-2010 period BVO data to calculate the production of electricity by Rogun HPP.

Expected Results from Simulations

The ESIA team expects the following results from the above mentioned simulations (without Rogun, during the filling period and after the filling period):

- inflow to Rogun
- volume and water level in Rogun reservoir
- outflow from Rogun to Nurek
- volume and water level in Nurek reservoir
- outflow from Nurek
- Vakhsh discharge pattern (with and without Rogun) downstream of the entire Vakhsh cascade
- Amu Darya discharge, with and without Rogun, at the point where it crosses the border into Uzbekistan (i.e. taking into account Pyanj and Kafirnigan.

8.7.2.2 Approach to Hydrological Assessments

Based on the input described in the previous section, the approach to hydraulic modelling was discussed (WB, POE and Consultants) and defined as described hereunder.

This assessment will be performed for a number of framework scenarios which are based on a set of assumptions on economic, environmental, social and political interests and requirements, both in a domestic and in riparian context. The scenarios will be modelled for all dam height alternatives generated either under technical or environmental and socio-economic assumptions. The following scenarios have been identified and sorted into 3 thematic groups:

Scenarios Group A: Hydrological Variability

1. Natural hydrographic curve of Vakhsh River (pre-Nurek) as baseline for comparison
2. Retaining current flow regime (volume over annual cycle) of Vakhsh River
3. Climatic stress and extreme hydrological situations (droughts, floods, PMF routing)
4. Filling period
5. Emergency drawdown
6. Sediment management (e.g. flushing cycles)

Scenarios Group B: Power Generation

7. Fully meet domestic power demand
8. Fully meet domestic power demand and maximize export potential

Scenarios Group C: Downstream Water Management

9. Riparian inputs and considerations on downstream water uses
10. Trends for changes in water use (domestic, riparian) and availability (e.g. due to climate change) based on selected indicators.

Each scenario should be assessed in the context of the motivations of the Tajik Government, of being technically feasible and economically sound and regarding its overall probability of actually being pursued.

Subsequently the water availability and related effects and impacts would be modelled based on the identified framework scenarios which for modelling purposes will be translated into demands and reservoir operation rules, which will feed into the model run parameters.

The core of the analysis will be a numerical operational model for the Vakhsh River Cascade which will address each of the scenarios identified above. As key outputs these models will produce (under each scenario): (i) power indicators (firm energy, peak power, exports); (ii) water flows and annual distribution at the end of the Vakhsh River Cascade, i.e. at the confluence with Pyanj River.

Based on the modelled changes of downstream water availability and flow regime, which would result from a given scenario, the parameters for the operational cascade model would be modified and optimized.

From the hydrological output of each scenario, i.e. the flow regime passing from Tajikistan to downstream riparian countries, the approximate range of the magnitude of potential impacts on a number of environmental and socio-economic indicators will be assessed for Tajikistan and downstream riparian countries.

8.7.2.3 Evaluation of Effects

Based on these results, it will then be possible to evaluate any effects that Rogun HPP might have on water demand and water users in the downstream area. Should adverse effects be detected, input conditions for the model will be modified in a way as to reduce or eliminate these effects.

For this purpose, relevant data on the downstream situation will be collected and analysed (mainly covering the water management system of Amu Darya as a whole, water allocation and distribution d/s of Vakhsh/Pyanj confluence, data on irrigation etc. However, it will not be attempted to create a complete model of water allocation in the entire Amu Darya Basin, which is, due to the extensive use of the resource and the multitude of structures and stakeholders involved (see overview in Section 8.2.4 and Figure 8-7) a very complex system.

The overall aim of the simulation should be to find a way for filling and operating Rogun HPP within the limits defined by Protocol No. 566, i.e. without creating any negative impacts on riparian states.

9 VEGETATION

9.1 Theoretical Considerations

The biological diversity of an area is made up by the number of species of plants and animals that exist there, and by the number and extent of habitat types which they inhabit and help to form. Furthermore, some areas contain a high number of endemic species, i.e. species that exist only in this area and nowhere else on earth.

A large number of species have become very rare or even extinct through the progressive shrinking of specific habitat types as e.g. primary forests or wetlands, sometimes in combination with other influences like hunting. Species that are rare by nature, as the large predators, especially attractive for one reason or another, as furbearers or "trophy animals", or that depend entirely on a specific, threatened habitat type as amphibians (wetlands) are especially vulnerable.

Hydropower projects can affect biodiversity mainly in the following ways:

- direct destruction of habitats, mainly by submerging large areas through formation of a reservoir;
- indirect disturbance through improved access to hitherto inaccessible areas or through the resettlement of the people living in the reservoir area to formerly natural areas;
- disruption of a river by formation of a lake (reservoir), by impeding migrations of aquatic species through construction of a dam. and by changing the downstream flow pattern in this river.

The first two points affect mainly terrestrial vegetation and fauna, while the third point refers to impacts on hydrobiology (fish and other aquatic life). In addition to these points, the construction phase can have a major impact on specific species, e.g. by increasing pressure on certain plants or animals, mainly be collecting or (usually illegal) hunting carried out by the work force.

9.2 Introduction

In the case of plants, two aspects have to be considered, namely:

- Flora, i.e. the individual species of plants living in the area under study. For impact assessments, emphasis lies on the most important or frequent plants (which constitute a characteristic feature of the area), on plants which are of special importance due to their being used by the local population (as food, construction material, fuel, medicine and/or for economic purposes), and on rare, endangered and/or endemic plants, which are important from a biodiversity conservation point of view.
- Vegetation: these are the plant associations to be found in an area, which determine to a large extent the visual aspect of this area (forests, grasslands, wetlands, steppes etc.) and which also constitute the main component of the habitat of animals. Today, in most places (natural) vegetation overlaps with and is influenced very much by all forms of human land use (agriculture, forestry, pasture, etc.).

The description of vegetation and flora of the area to be affected by the Project will focus on vegetation on the land used for construction and to be submerged at reservoir impoundment, of any other land that might be occupied by the project, and on wetlands in the d/s area that might be affected by changes in river discharge pattern by the Project (mainly Tigrovaya Balka National Park). In the present period of the study it is not yet possible to evaluate the impact on the downstream area since no data on the area between Rogun HPP and the Nurek reservoir are available so far.

9.3 Material and Methods

The main work carried out so far was the revision of existing documents. The most important assessment of the vegetation cover of the flooding area of Rogun HPP has been carried out by "Hydroprojekt" for the main Technical Report, Part II, Chapter 4: Nature resources and nature protection of 1978 (№ 1174 – T19).

Furthermore, several scientific studies (Grigoriev (1940, 1944, 1948, 1951), Nikitin (1938), Zaprjagaevoj (1964, 1970, 1976), Goncharov (1937), Sidorenko (1953, 1956), Sidorenko, etc. (1964), Shukurova (1963, 1970), Kaletkinoy (1961, 1971)) were used to draw a picture of the region.

In addition, field work has been carried out in the project area, covering a number of characteristic site within the area of the future reservoir. analysis of the date from this work is still under way, the results will be included in the ESIA report.

9.4 Prevailing situation

9.4.1 Stratification of the Vegetation in the Catchment Area

The project area is located within the Hissar-Darvaz floristic region, which covers a wide area in the central parts of Tajikistan. Its limits are the ridges of Hissar mountains to the north and the Alai mountains to the south. Westwards it extends as far as the border with the Republic of Uzbekistan.

The region is characterised by a number of ridges (Alai, Hissar, Karategin, Peter I and Darvaz), which extend mainly in a northeast to southwest direction. The elevation is considerable, the highest peaks of the Hissar range reach 5'400 to 5'700 m asl. Due to the general direction of these ridges, winds from southwest bring moisture into the valleys. The area covered by glaciers is relatively small, but still several 100 km².

Summers are hot and dry, precipitation falls mainly in winter and spring; however, overall precipitation is rather high as compared to other parts of Tajikistan. At lower elevations in the Hissar range, between 700 and 1'000 m asl, annual precipitation is 500 to 800 mm, reaching as much as 1'600 mm or more at elevations of 2'000 to 3'000 m asl (Gusharov, Khoja Obigarm). The highest values are reached on the Peter I ridge and on the southern slopes of Hissar.

The foothills generally do not receive snowfall, but at higher elevations snow cover usually reaches 1 m and lasts for 200 to 250 days.

Due to this rather abundant rainfall, vegetation in the Darvaz-Hissar region is the richest and most diversified of all of Tajikistan. It was the object of a considerable number of scientific studies and for that reason it is quite well known.

The zonation of the vegetation according to elevation is described here shortly.

1. Elevations from 700 (1100) - 1500 (1800) m asl - The lower parts of this belt are mainly meadows dominated by wheatgrass (*Agropyron* sp.), in the past they have been in association with almonds and cherries which mostly disappeared. The upper parts of the belt are covered by mesophilic broad-leaved forest consisting of trees and shrubs; on shadowy northern slopes, these descend as low as 1’000 m asl. Important tree and shrub species are *Amygdalus bucharica* (almond), *Crataegus pontica* (korsh), *Pistacia vera* (pistachio), less often *Acer regelii* (maple), *Celtis caucasica* (Caucasian hackberry), *Zizyphus jujuba* (jujube), and *Cotoneaster racemiflora*. Important plants in the herbaceous layer are *Elytrigia trichophora* (wheat grass), *Hordeum bulbosum* (barley), and the viviparous *Poa bulbosa*. The grasses *Cynodon dactylon* and *Botriochloa ischaemum* dominate on abandoned fields. 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.

2. Elevations from 1500 - 2500 m asl - the belt of mesophilic broad-leaved forest vegetation characterised by junipers (*Juniperus* spp.). Other important species are *Prangos pobullaria*, *Juglans regia* (walnut), *Acer turkestanicum* and *A. regeli* (maples), *Vitis hissarica* (common grape) and *Platanus orientalis* (sycamore); they are accompanied by a number of smaller tree species like *Prunus divaricata* (cherry plum), *Padellus mahaleb* (cherry), *Malus sieversi* (apple) and *Juniperus zeravashnaica* (juniper).

   Depending on slope and exposure, the composition of the vegetation in this zone can be quite different. On terraces with a northern exposition mesophilic forest with *Juglans regia* (walnut) can be found which are characterised by the shade requiring *Impatiens parviflora*. In valleys and on northern slopes *Juglans regia* (walnut) and *Acer* spp. (maple) forests, often mixed with *Populus* spp. (poplar) occupy a considerable space. Southern slopes are often treeless or show open stands of *Acer* spp. (maple), *Celtis caucasica*, *Crataegus*, *Amygdalus bucharica* (almond), together with herbaceous species as *Agropyron* sp., *Eremurus* sp., and *Prangos pabularia*.

   Stands of junipers (*Juniperus* sp.) are well represented here, often together with *Pyrus bucharica* (Bukhara pear) and *Malus* spp. (apple).

   The uppermost band of this zone, between 2’300 and 2’500 m asl is characterised by the most heat tolerant tree species as *Juglans regia* (walnut), *Platanus orientalis* (sycamore), and *Juniperus zeravshanica* (juniper). *Acer turkestanica* is a dominant species here, while *Acer regeli* and *Celtis caucasica* usually do not grow here. These open forests with high grasses are often combined with meadows, treeless spaces of significant extent, dominated by *Polygonum coriarium* and other tall meadow herbs. Open stands of *Juniperus turkestanica* and *J. semiglobosa* are often combined with a xenomorphic ground vegetation dominated by *Ziziphora pamirolaica*, *Dianthus seravschanicus*, *Hypericum scabrum*, *Cousinia pseudobonvalotii* and *Onobrychis echidna*.

3. Elevations from 2800 - 3400 m asl is a belt of subalpine meadows. Due to rainfall and a rather low snow line, this vegetation type develops here at lower altitudes than in other regions of Tajikistan. *Juniperus turkestanica* still grows here, in addition to many shrubs as *Lonicera* sp. (honeysuckle). Grass cover consists of *Festuca sulcata*, *Poa relaxa*, *P. litwinowiana*, *Polygonum eoriarium*,

Poa bulbosa (bluegrass) and *Phlomis* sp. *Onobrychis echidna*, *Astragalus lasiosemius* as well as *Astragalus nigrocalyx* associations are rather widespread. Other subalpine meadows are formed by *Eremurus zeravshanica* (foxtail), *Festuca rubra* (red fescue), *Geranium montana*, *Ligularia Thompsonii, Agrostis canina*, *Zerna turkestanica*, *Allium fedtschenkoanum* and others.

Steppes occupy a more modest place in the area, they are usually dominated by fescue (*Festuca* sp.) in combination with *Stipa kirgisorum, Geranium montana* in moister and *Cousinia stephanophora* in more stony places.

4. Elevations from 3400 - 3800 (4000) m asl - a belt of Alpine meadows. In general xerophytic meadows of different types. Meadows dominated by *Carex* sp. (sedges), *Cobresia pamirolaica* and *C. capilliformis* are the most humid type. Other important species are *Carex pseudofoetida*, *Carex melanantha*, *Potentilla gelida, Eremurus zeravshanica* and *Poa karategensis*.

   The dryer steppes are characterised by *Atropis subspicata*, *Festuca coelestis*, *Festuca sulcata* and *Poa litwinowiana*, accompanied by *Hedysarum cephalotes* an *Sibbaldia olgae* and sometimes by the "pillow plants" *Oxytropis immersa* and *O. savellanica*.

9.4.2 Vegetation Cover in the Area Affected by Rogun HPP

The vegetative cover around the projected Rogun water basin is non-uniform and ca n be subdivided into different belts.

As mentioned above, geobotanically the project area belongs to the Hissar-Darvaz floristic region, which is characterized by mid-mountain mesophilic broad-leaved forest. However, there is also a considerable xerophytic element. Very often the vegetation cover shows a mosaic of these two types, which is explained by different exposures of the slopes.

The vegetation cover changes in a horizontal direction due to unequal distribution of precipitation, which decreases from west to east. So, the vegetative cover of Garm and adjacent with it Romit, Komsomolabad and Tavildara changes from west to east. This is reflected in a gradual reduction of abundance and a deterioration of the development of mesophilic tree species like *Juglans regia* (walnut) and *Acer turkestanicum* (maple). *Exochorda*, a small genus belonging to the Rosaceae family is pinching out and to the east the mid-mountain mesophilic deciduous forest is dominated by *Rosa* spp., which are replacing the *Exochorda* species. Here the vegetation is characterized by a large xerophylisation of the vegetative cover.

The lower border of mid-mountain mesophilic broad-leaved forest belt is located in the average mountain zone, at a height of 1100 to 1500 m asl., and the upper border at 2400 to 2800 m asl. In general the limits of the mid-mountain mesophilic deciduous forest belt are within 1500 - 1800 m asl to 2600 - 3000 m asl.

The mid-mountain mesophilic broad-leaved forest belt vegetation is presented by following types:

1. Black forest (Broad-leaved forest) – Characteristic species of mesophilic broad-leaved thermophilic trees are *Juglans regia* (walnut), *Acer turkestanicum* (maple), *Exochorda* and *Rosa* spp.;

2. White Forest - hygrophilous tree species – *Betula spp.* (birches), *Populus* spp. (poplar);
3. Shiblyak - uniting formations of xerophilic communities – *Amygdalus bucharica* (almond), *Crataegus pontica* (korsh), *Pistacia vera* (pistachio);
4. Juniper forests - formations of evergreen cold tolerant and xerophytic species.

The mid-mountain mesophilic broad-leaved forest belt can be further divided in its vertical direction into two belts: in the lower part, which is dominated by shrubs, (mainly *Exochorda* sp., a species of Rosaceae typical for this association) and tree species (walnut and maple) extending to an elevation of 2300 - 2400 m asl, and the upper part, which is dominated by *Rosa canina* (yellow dog rose) with light maple forests.

The *Exochorda* are the most common species on the left bank of the Obikhingou river. They form the basic background of the black forest. *Exochorda* thickets develop depending on the steepness of the slopes: on gentle slopes they can cover areas of 400-500 m. They form a dense thicket at elevations between 1600 m asl and 2700 m asl., and can be found on both flat and steep slopes. In addition to *Exochorda* sp. there are *Acer turkestanicum* (Turkestan maple), *Amygdalus bucharica* (almond), etc. Within the herbal stratum vegetation types dominated by *Exochorda* (on the left bank of the river) are semisavannoid with a dominance *Prangos pabularia, Hordeum bulbosum* (bulbous barley), *Scabiosa dzungarica*, etc.

The upper part of the mid-mountain mesophilic broad-leaved forest belt is dominated by *Rosa* spp. associations, which occur at the left bank of Obikhingou river, from the river bank up to 3000 m asl. Characteristic tree species in this belt are *Acer turkestanicum* (maple) and on stony sites individual specimens of *Juniperus zeravashnaica* (juniper).

The herbaceous layer on the left bank of Obikhingou river consists of meadows dominated by tall herbs, usually associated with wild roses (*Rosa* spp.) and maples. The wood vegetation is represented basically by maple forest and less often by walnut trees.

Maple forests are in general plantings with a variety of flowering shrubs and grass societies. The maple forests are occupying the lower parts of mid-mountain mesophilic broad-leaved forest belts.

The distribution of *Juglans regia* (walnut) is rather limited, they are represented by small patches among the *Exochorda* vegetation and maple forests, and mainly located on the lower parts of slopes, on river terraces and on river banks slopes. The walnut groves look like parks. The second society is represented by shrubs, like *Rosa canina* (yellow dog rose) and/or *Prunus divaricata* (cherry plum). The grass cover is sparse, shade-tolerant mesophyte plants are predominating, the plant society consists usually of the grass *Poa bulbosa* as well as *Senecio* sp. and *Tanacetum spp.*, etc.

Another vegetation type called shiblyak vegetation is dominated by *Amygdalus bucharica* (almond) and *Padellus mahaleb* (cherry). The highest concentration of almonds is located in the south on gravel and stone-gravel slopes in the lower part of the mid-mountain mesophilic broad-leaved forest belt.

The so called "white forest" is characterized by poplar, birch and willow associations, with a high distribution in the eastern part of the area, mainly located at the lower parts of the mid-mountain mesophilic broad-leaved forest belts at the lowlands and terraces of the rivers and the river bank slopes.

The riparian forest is distributed as small patches in the alluvial valleys of Vakhsh, Surkhob and Obikhingou rivers. They form sparse phytocenosis on gravelstone areas, consisting of *Elaeagnus angustifolia*, *Salix purpurea* (purple willow), and *Hippophaë* sp. (sea-buckthorn). The herbaceous layer consists mainly of different grass species (Gramineae) and a variety of herbs (mainly Compositae, Labiatae and Papilionaceae). The ecological uniformity is typical for these societies. The upper societies are represented by mesophytic broad-leaved forest. The herbaceous layer usually has a xerophilous character (increased insolation and evaporation leads to a deficiency of moisture in summer).

Desert and semidesert ecosystem vegetation types occur only in small patches and are mostly degraded. Ephemerous desert vegetation (i.e. plans growing rapidly as soon as suitable conditions, mainly defined by scarce and irregular rainfall) can be found within the catchment area only in the Vakhsh river valley, between the two tributaries Mudshiharova and Obikhingou, on a narrow strip on river terraces, occupying a small area. The present situation is that large parts are degraded by ploughing and used for agricultural crops.

Further to the east on the gravelstone terraces of Vakhsh river the ephemerous - sage-brush (*Salvia* spp.) association is common. This area is also used for agricultural activities and therefore the ecosystem is not widespread anymore. Therefore only small fragments of this vegetation type persist. Rhubarb (*Rheum praksimovichil*), and buckwheat (*Polygonum* sp.) are growing on stony places, and *Prangos pabularia* is growing moist spots. This belt is used in autumn by nearby villages as pasture.

Thus, the catchment area is located in a belt of mesophilic broad-leaved forest, which shows clear signs of degradation due to human use (agriculture, pasture). There are also differences due to natural conditions. These changes in vegetative cover can be observed both vertically (by increasing elevation) and horizontally, from west to east, related to changes in precipitation. The development and abundance of trees decreases from west to east, where walnut, maple and *Exochorda* are increasingly replaced by associations dominated by wild roses (*Rosa* spp.), which are more xerophytic (tolerant of hot and dry conditions).

Species occurring in the project area which are listed in the Red Data Book of Tajikistan are given in the following Table. None of these species is restricted to the project area, and the project will not endanger any of them.

Table 9-1: Red Data Book species found in the project area

Scientific name	**English name**	Russian name	
Campanulaceae			
Ostrowskia magnifica			
Crassulaceae			
Rosularia lutea			
Iridaceae			
Iris darwasica			
Iris Hoogiana			
Juno baldshuanica			
Liliaceae			
Allium Suworowii			
Petilium Eduardii			
Tulipa linifolia	Slimleaf Tulip		
Tulipa praestans			
Paeoniaceae			
Paeonia intermedia			
Rosaceae			
Rosa longisepala			

9.5 Impacts on Flora

The Project will destroy the mesophilic broad-leaved forest including the herbaceous vegetation in the submerged area. However, as has been shown above, there are no plant species, including the species listed in the Red Data Book of Tajikistan, which are restricted to this area and would therefore disappear from the wider area of the Hissar-Darvaz floristic region.

One important point here is the amount of vegetation submerged in the reservoir at first filling, which will then decompose. As the decomposition of plant material consumes high quantities of oxygen, this can lead to anaerobic conditions in water deeper than 5-10 m. This in turn can produce problems when this water is used for power generation and then discharged downstream, as it can contain toxic substances (mainly H_2S). Furthermore, it needs to be mentioned that under anoxic conditions, the ongoing breakdown process of the biomass leads to the production of methane (CH_4), which is one of the major greenhouse gases. These problems arise mainly in the case of reservoirs in the humid tropics, where very high quantities of biomass can be present in the reservoir area. Mitigation for this problem in such cases consists in a thorough pre-impoundment reservoir clearing. This topic is addressed in Section 8.1.4.

While first estimates show that oxygen depletion due to submerged biomass will probably not be a major problem, it is still recommended to carry out a pre-impoundment reservoir area clearing. This will have two main objectives, namely:

1. To make use of timber and other useful wood (e.g. fuelwood) growing in the reservoir area. This is a valuable resource which would otherwise be lost due to reservoir impoundment. Trees should be cut before submersion and wood that can be used should be removed from the area.
2. To reduce the amount of biomass. Even if this would not constitute a major problem, it is still preferable to reduce the amount of submerged biomass as far as possible. For this, the best way is to cut the vegetation, let it dry and then burn it (the parts that cannot be used otherwise). Obviously, care has to be taken to prevent such fires from spreading beyond the future reservoir water level.

Rogun reservoir will be filled in stages (see Figure 18-1 in Annex 3). The pre-impoundment clearing will have to be in coordination with this staged filling, with the aim of clearing areas as shortly before impoundment as possible, in order to prevent regrowth. In the last stage, for reaching the FSL of 1290 m asl, care will have to be taken not to cut any trees, and not to burn any vegetation above this level.

A more detailed outline of reservoir area clearing plan will be provided in the ESIA report.

9.5.1 Impact of construction

First of all it needs to be mentioned that the construction already started in the 1980ies. Thus, the vegetation cover within the construction area is already degraded due to the past construction activities, the clearance of the dam site and appurtenant structures like camp sites, access roads, etc. have been carried out a long time ago. Therefore the additional impact is estimated to be negligible, as long as additional dumping sites outside the future reservoir area are kept as small as possible; any excavation material, e.g. from additional tunnelling, should be used for the dam construction, whenever possible. Strong efforts needs to be taken to reduce the erosion (see Chapter 16).

9.5.2 Impact of Rogun HPP

The analysis of the date from field work is not completed yet, and a final statement on the impact of the Project on vegetation will be made in the ESIA report. However, given the fact that no particular and unique species or habitat types have been identified in the affected area, and that the plant species growing inside the reservoir area can also be found around the reservoir and in other parts of the country, the impact on vegetation can already be qualified as rather small. The magnitude of the impact is obviously related to the area which will be inundated.

9.5.2.1 Impact of Stage 1

In stage 1 none of the larger important floodplains upstream of Chorsada will be affected and, if at all, just very small patches of mesophilic broad-leaved forest on the slopes of the two small right bank tributaries shortly upstream of the dam site will be submerged.

Furthermore small areas of the meadow areas will be submerged but most of those areas submerged in stage 1 are strongly degraded due to the construction activities which already have started a long time ago.

9.5.2.2 Impact of Stage 2

Stage 2 will submerge 170 km^2. A 70 km long stretch of floodplains including the riverbank vegetation and the walls along the river will be submerged. Two rather special floodplain habitats are located within that area, one between Chorsada and Nurobod (Komsomolobad), the other between the origin of Vakhsh river at the confluence of Obikhingou and Surkhob, stretching along the later to the upstream end of the reservoir. The mesophilic broad-leaved forests, which are mainly existent on the steep slopes of the tributaries to both sites of the Vakhsh river and a rather large part of the meadow area will be submerged.

Furthermore, the indirect effect could strongly increase depending on how many people will be resettled and how many will stay in the region. The question here is whether the carrying capacity of the remaining land will be sufficient for the number of people and their livestock.

In order to improve the situation (replacement for forest area lost, reduction of erosion, improvement of living conditions of the remaining population in the area, it might be necessary to develop and implement a tree planting program. If this should be done, it would be important to chose species which are adapted to the local conditions, like e.g. poplars, apricot, apple and mulberry.

Furthermore, it might be advisable to develop a watershed management and monitoring plan. This would include reforestation and other possible measures to minimise the erosion of the slopes, but also to increase productivity of pastures and forests. Such a plan would need to take into account the human activities (agriculture, pasture), training of the population concerning sustainable farming and husbandry (correct plantation, seed selection, irrigation, plant pests, etc.).

However, these are only first indications to show in which direction recommendations for compensation measures might go. A final, more detailed recommendation will be made in the ESIA.

9.6 Next Steps

A survey was carried out in June 2011, to have a thorough view on the important habitats in that region and to check which protected species actually are located in that area. Analysis of the date is presently under way. It is known, however, that most of the species identified are widespread and do not only occur in the project area.

The results of this analysis, together with final recommendations on mitigation measures, will be provided in the ESIA report.

10 TERRESTRIAL FAUNA

10.1 Theoretical Considerations

The statements made in the Chapter on Vegetation on biodiversity aspects in dam projects are largely valid for the terrestrial fauna as well, since animals largely depend on their habitats.

One specific issue that often needs to be considered is the potential impact of a project on migrating species (especially birds). This is insofar of importance that a specific site - as is the case for many wetlands - can be of high importance for the survival of animal populations and species even if they do not live there permanently, but use this area only at specific times of the year, e.g. as resting and feeding places during migrations or as overwintering areas.

10.2 Introduction

In the framework of an EIA, it is never possible to study all the animal groups living in the study area. The efforts have to concentrate on groups of animals which can more or less readily be identified and whose habitat requirements are known well enough, and which can therefore serve as indicator organisms for the state of their habitats. As for plant species, the emphasis lies on either economically important species (food or other uses, pests) and on rare, endangered and/or endemic species. The most important groups in this sense are mammals and birds, and reptiles and amphibians. For the entire aquatic fauna, fish serve as indicator organisms.

10.3 Material and Methods

The main work, which has been carried out so far was the revision of existing documents. Background information on fauna in the region was extracted from articles and books from researchers like I. Abdusalyamov, V. Stalmakova, Isakov, Popov, and others.

In addition, the report of the Technical Project for Rogun HPP on the Vakhsh River (Part Two, Volume 4-I), “study on species composition of birds and terrestrial vertebrates”, carried out by the Research Institute “Hydroproject” in 1978 has been reviewed.

In 1978 147 bird species representing 15 orders were detected, which have been referenced to the vegetation zones; a complete list was not included in the technical report. The information on reptiles and mammals seems to be rather complete.

The Study carried out in 2009 by Hydroproject concentrates on the species composition of mammals and birds listed in the Red Book of the Tajik SSR (Dushanbe, 1988).

This data have been verified with following literature:

- “Birds of the USSR”, Dementiev et al, 1954;
- “Birds of the USSR”, Flint et al, 1968;
- “Fauna of the Tajik SSR, Birds”, Abdusalyamov, 1973;
- “Nature and Wildlife in Central Asia”

For June 2011 a field survey is scheduled to identify the important habitats within the reservoir area and to identify the occurrence of protected species like *Lutra lutra seistanica* (Eurasian otter) within that habitats. The planning of the following steps will be carried out depending on the results of the first survey.

10.4 Prevailing situation

Until now two species of amphibians, 12 reptiles, 37 species of mammals and 154 species of birds have been identified in the project area.

Birds and amphibians have been identified with reference to their habitats (ecosystems). Many bird and mammals (mainly carnivores) occupy due to their ability very different habitats. Some migrate depending on the season from one habitat to another and others visit the project areas only during their seasonal migrations.

Five main vegetation zones have been identified in the project area. The following list gives a short summary on the habitats concerning the number of animals which occur in each habitat (See Annex 10 for species lists):

1. The floodplain of the Vakhsh River and riparian vegetation are particularly important. Both amphibian species and 5 reptiles can be found in the floodplain area. The *Vipera lebetina* (Blunt-nose viper) is categorised as 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 categorised by IUCN as near threatened. 44 bird species are representing the floodplain habitat, 26 of them are nesting in that habitat, and 18 species, mainly water birds (ducks, goose, little egret, gray heron etc.), can be counted as migratory species for spring or autumn.

2. Elevation from 700 (1’100) up to 1’500 (1’800) m asl. The lower parts of this belt are mainly meadows dominated by wheatgrass (*Agropyron sp*.), while its upper parts are covered with trees. Most of the species, which can be found here prefer wide and open areas with clusters of woody vegetation. It is the habitat with the highest number of reptiles (10 species). Furthermore one of the two amphibian species occurs in that region and at least 51 bird species, among them one endangered species, *Neophron percnopterus* (Egyptian vulture), and two near threatened species, *Aegypius monachus* (Cinereous vulture) and *Coracias garrulous* (European roller). Almost all species of larks are found in this habitat and it is used by several birds of prey as feeding territory, among them all kinds of scavengers. The migration routes of many birds passes through this belt, even those which during the nesting period prefer completely different biotopes like plovers, twits and re-capped finches. The most noticeable birds of this zone are rose-colored starlings, mynas and field sparrows.

   Mammals are rather well represented (26 species) in this habitat in view of species composition. There are hedgehogs, and 10 kinds of chiropterans, frequently using dwellings in settlements as habitat. The Himalayan brown bear, which is listed as endangered species by the IUCN Red List, as well as the wolf and the fox. All three carnivores are listed by CITES, the first two in Annex I and II, the fox in Annex III. Furthermore steppe cat, badgers and weasel occur in this habitat.

3. Elevation from 1500 up to 2500 m asl. This belt is dominated by trees and shrubs, characterised by junipers (*Juniperus spp*.); another important specie is *Prangos pobullaria.* In this zone the amphibians almost disappear, and the number of reptiles is reduced to 7 species. However, the number of mammals increased to 28, the Central Asian lynx can be added for the carnivores and some of the rodents changed. The number of nesting bird species increased up to 52. However, such groups like larks are disappearing, and meanwhile mainly forest species appear - starlings, grosbeaks and green linnets. It is necessary to note hawks from birds of prey, as well as hobby. None of the threatened bird species appears in this belt, since the vultures nest higher and are foraging in areas with less vegetation.
4. Subalpine meadows are in the project area located between 2800 up to 3400 m asl. They are characterised by heaths, thorny grass and juniper elfin wood (*Juniperus sp.*). No amphibians occur anymore in that height, the reptiles are keeping the number of species stable, the mammals decreased to 14 species and the birds to 44 species. Insectivores and chiropterans are not anymore existent in that height, carnivores are represented by six species, two of them are in the category of endangered species (Himalayan brown bear, snow leopard). Furthermore the ibex, tolai hare, pika, marmot and some species of voles can be found. Three of the species among the birds of prey are in the Red List of IUCN: *Neophron percnopterus* (the Egyptian vulture) is endangered, *Falco cherrug* (the Saker falcon) is vulnerable, and the near threatened one *Aegypius monachus* (the cinereous vulture) is listed as near threatened. In this zone migrants are practically absent.
5. Alpine short grass meadows, heaths and thorny grass, as well as pollster plants are located from 3400 up to 3800 (4000) m asl. Just three reptiles can be found in that altitude. The number of bird species is reduced to 11 and the number of mammals as well. Five of the eleven species are bird of prey and six of the eleven mammals are carnivores.

10.5 Impacts on Fauna

10.5.1 Impact of construction

The main impacts on the terrestrial fauna resulting out of the construction of Rogun HPP will be the disturbance caused by noise and the presence of a high number of people, which includes the risk of illegal hunting. It should be mentioned that this situation is not a new situation since the construction of Rogun HPP already started in the 1980ies, but the workforce will increase when the construction of the main dam starts.

10.5.2 Impact of Rogun HPP

The prevailing situation describes five important ecosystems, the floodplain habitat is a special habitat passing through the four belts (altitudinal zones). Rogun HPP will have a direct impact on all the species within the reservoir area depending on the stage either up to 1110 or up to 1290 m asl, since this area will be submerged and the habitats will disappear. Furthermore, it will have an indirect impact on the area above either 1110 m asl for stage 1 or above 1300 for stage 2. The indirect impact will be caused due to a higher pressure on those habitats from human activities (overgrazing, fuelwood collection, hunting etc.). The difference between the impacts of stage 1 and stage 2 is the size of the area which will be submerged.

The directly affected habitats are the floodplains with the riverbank vegetation, which is the habitat of the two amphibian species and of *Lutra lutra seistanica* the Eurasian otter and the walls along the river, which are composed of river sediment, gravel and loess/silt. These walls are used by several birds like European Bee-eater (*Merops apiaster)*, Common Kingfisher (*Alcedo atthis*), Common Myna (*Acridotheres tristis*) sparrows, pigeons and doves, etc. as breading areas. There is an effect on carnivores (brown bear, wolf, fox) which are protected but since their distribution is from 700 m asl up to 3800 it will be probably a minor impact.

The second area directly affected will be the belt were the lower parts are mainly meadow and dominated by wheatgrass and were the upper parts or the areas with a steeper slope are covered with trees and shrubs. In this area most of the larks, shrikes and wheatears are breading and the birds of prey use this area as foraging area.

Part of this area, all above either 1110 m asl or 1290 m asl might be indirectly affected by a higher human pressure.

10.5.2.1 Impact of Stage 1

In stage 1 none of the larger important floodplains upstream of Chorsada will be affected. Still, one important breading habitat, the walls along the river will be affected, but similar walls, although maybe not of this height, can be found further upstream than 1110 m asl.

Furthermore small areas of the meadow areas will be submerged but most of those areas submerged in stage 1 are strongly degraded due to the construction activities which already have started a long time ago.

10.5.2.2 Impact of Stage 2

Stage 2 will submerge 170 km^2. A 70 km long stretch of floodplains including the riverbank vegetation and the walls along the river will be submerged. Two rather special floodplain habitats are located within that area, one between Chorsada and Nurobod (Komsomolobad), the other between the origin of Vakhsh river at the confluence of Obikhingou and Surkhob, stretching along the later to the upstream end of the reservoir.

A rather large part of the meadow area will be submerged. The indirect effect could strongly increase depending on how many people will be resettled and how many will stay in the region and if the area is capable for the amount of people and the livestock.

10.6 Next Steps

A survey was carried out in June 2011, to have a thorough view on the important habitats in that region and to check which protected species actually are located in that area. For several species distribution and frequency needs to be verified, especially for those which occur only in the mentioned habitats like otters, bee-eaters, larks, etc.. It is known, however, that most of them are widespread and do not only occur in the project area. The analysis of the field data will be included in the ESIA report.

11 AQUATIC FAUNA

11.1 Theoretical Considerations

The main effect of a dam and reservoir project on fish populations is often the fact that the dam will constitute an obstacle to migration. Many species of fish carry out migrations, and some of them depend on these migrations for reproduction.

A second effect on fish is the fact that a part of the river will change from rive to lake conditions. While some species can adapt easily to this type of habitat, others cannot and will therefore diminish in numbers or will disappear altogether from this area.

A third potential effect on fish can be caused by a change in river flow pattern d/s of the dam, e.g. in cases where seasonally flooded areas serve as breeding grounds, and when this flooding no longer takes place due to the regulating effect of the dam.

Finally, fish populations can be affected by the indiscriminate introduction of exotic species (which is sometimes done as mitigation measure for a dam project, but very often independently of that, e.g. by introducing the exotic rainbow trout, a good sport fish, in European and Asian waters, often to the detriment of native species).

11.2 Prevailing Situation

The ESIA for Rogun will have to take into consideration that Nurek dam was built about 30 years ago approximately 70 km downstream of Rogun dam site. This means that any fish migrations that might have occurred here from Amu Darya or the lower parts of Vakhsh river to its headwaters have already been interrupted. In addition to that, apparently a certain number of exotic species of fish were introduced into Nurek reservoir.

11.2.1 Experience with Reservoirs in the Area

Dams are usually built, and reservoirs created, for generating hydropower and/or for providing water for irrigation. However, reservoirs can also be used for fishing and fish farming.

In the Sukhd region, on Syr Darya, two reservoirs have been built, Farkhad, with an area of 4.8 ha, in 1947, and Kairakkum, with an area of 52’000 ha in 1956. Originally, these waters were inhabited by 18-20 species of economically interesting fish. Therefore, fisheries in these reservoirs was organised in the early days of their existence. In Kairakkum reservoir, рыбпромхоз (fisheries management) started to be organised in 1962 and has yielded 300-400 t of fish annually since then.

Before the creation of these two reservoirs on Syr Darya, two endemic fish species, the Syr Darya shovelnose sturgeon (сырдарьинский лжелопатонос, *Pseudoscaphirhynchus fedtschenkoi*) and the Aral schip or fringebarbel sturgeon (аральский щип, *Acipenser nudiventris*) lived in this river. After the construction of the power plants, these two species gradually disappeared. However, the reservoirs proved to be a suitable habitat for other species, which developed well and created a good basis for fishing. In addition, a number of species were introduced to this area.

In 1973, Nurek reservoir was created, with a surface of 9.8 km². Other than Kairakkum reservoir, Nurek is a mountain reservoir, narrow, with steep slopes, a maximum depth of almost 300 m, and a normal yearly drawdown of up to 50 m. Inflowing water is cold even in summer. At the surface of the reservoir, water temperature in summer reaches 22 to 23°, and below a depth of 10 m temperature does not exceed 10°C, indicating a stable thermal stratification of the reservoir. These conditions, together with a low nutrient content, make the reservoir unfavourable for fish.

Many fish species carry out up-or downstream migrations. The purpose of these migrations is either the search for food, for suitable spawning or wintering sites. Most of the time however, 9-10 months out of 12, such movements are in search of food. Before the construction of Nurek dam, there probably were some species which carried out migrations from the Amu Darya upstream into Vakhsh river beyond Nurek and Rogun sites. A check of the scientific literature is under way in order to see whether there is any confirmed information available on such migrations. In any case, such long range migrations would have been interrupted by Nurek dam.

Some information is available on the development of Nurek reservoir. In the first two years of the filling phase, it was rather sterile, with very low nutrient contents of the water. Gradually, with the submersion of additional areas and the vegetation covering them, nutrient content in the water increased. This led to the growth of algae (phytoplankton) and zooplankton, and this in turn was a food basis for some fish species. This was sufficient for maintaining a good fish population (and corresponding fisheries) during a period of 10 years. This population consisted mainly of common marinka, Samarkand khramulya, Turkestan catfish, Amudarya trout etc. However, once the reservoir had 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 Nurek reservoir at the beginning of the filling phase. The population grew over the first few years, but after the end of the filling phase, due to the development of more oligotrophic condition (lack of nutrients), it then died out again.

11.2.2 Field Work

A first part of field work was done in the period of May 5-9, 2011. Working conditions were rather difficult in this period, due to heavy rainfall during most of this time. This also lead to rather muddy water in all rivers, a situation which does not facilitate sampling of fish or their food organisms. During this period, the section of Vakhsh river between Obi Garm and Chorsada was examined, including tributaries along this part of the river (a small lake and Obi Garm near the village of the same name, Lufirarf, and Mudzhiharv and Hakimi near Chorsada). Water temperature was around 12 to 13.5°C. Main aim was to identify species of fish living in this area, as well as obtaining information on feeding places and preferred food. For this purpose, benthos was sampled, and stomach content of caught fishes were examined. Places with different substrate (rocks, gravel, sand) were examined.

The following list provides information on important benthic organisms identified and on the frequency of their consumption by the fish caught in the area:

- 2 species of oligochaete worms; eaten by marinka (found in the stomachs of 40% of caught specimens).
- 2 species of caddis flies; used by 100% of marinka and Turkestan barbel.

- 6 species of mayfly larvae; used by 100% of marinka and Turkestan barbel.
- 12 species of chironomid larvae; since they live on or within the sediment, they are eaten only by the Turkestan catfish (found in 25-30% of specimens).
- 2 species of molluscs; not consumed by more than 5% of the fish.
- Algae growing on stones (aufwuchs) are eaten by 100% of the fish.

As can be seen from this, main food for fish caught in Vakhsh river feed on sessile algae (growing on stones) and on benthic organisms (worms and insect larvae).

11.2.3 Fish Fauna in the Project Area

The fish fauna in the project area includes common marinka, Turkestan catfish, Amudarya trout, rainbow trout, brown trout, Tibetan stone loach, and crested loach (обыкновенная маринка, туркестанский сомик, амударьинская форель, радужная форель, аральский лосось, тибетский голец, гребенчатый голец) (see Table 18-15 in Annex 11 for a list of fish species with scientific, Russian and English names).

Carps were not caught during this period, but according to local fishermen rather large carps are sometimes caught; these are then sometimes sold in local markets. The carp is not a migratory fish and thrives in lakes and ponds.

11.2.4 Observations on Fish Biology

Most migrations are carried out in search for food; this is done year round with the exception of a short pause in winter. Spawning migrations are carried out mostly in spring, for some species in fall.

Characteristics of the three most frequent species:

- **Amudarya trout (*Salmo trutta oxianus*):** body length 23-32 cm, weight 240-560 g; a female produces 1200 to 6800 eggs. The specimens caught in May did not have eggs, their spawning period is autumn (September to December), when it carries out spawning migrations. The species was found in Mudzhiharv creek, where the water was relatively clear. Local fishermen confirmed the suitability of this tributary for this species.
- **Common Marinka (*Schizothorax intermedius*):** frequent in all tributaries and in the Vakhsh itself. Size is 17-52 cm, weight up to 1600 g. This is the most frequent species in this area, and most important one for fishing. The fishing gear used most often to catch it is a local type (sabat), a screen woven from twigs with a narrow, cone-shaped inlet. The reproduction period is June, when it migrates to smaller tributaries for spawning.
- **Turkestan catfish (*Glyptosternon reticulatum*):** this is rather small a bottom dwelling fish with a flattened head and body. It feeds on benthic organisms, algae and organic sediment.

Table 11-1: Characteristics of caught fish

Scientific name	English name	Виды рыб	Number caught	Length (cm)	Weight (g)	Age (years)
Schizothorax intermedius	Common marinka	Обыкновенная маринка	5	12.5-15	57-70	2+
Salmo trutta oxianus	Amudarya trout	Форель амударьинская	3	13.3-26.5	76.6	2-3+
Glyptosternon reticulatum	Turkestan catfish	Туркестанский сомик	4	7.2-14.1	35.0	1-4+

11.3 Effects of Rogun Dam

Rogun will be built mainly for generating electricity, and possibly for regulating water for irrigation; however, no water will be diverted directly from Rogun reservoir for irrigation purposes. It will, however, have some negative impacts on the fish fauna of the river.

The most important effects will be:

- Chang of a part of the river from river to lake conditions: the fast flowing water with temperatures of 5-6°C in winter and 12-13°C in spring will change to stagnant water with a thermal stratification, and temperatures near the surface of up to 20°C or more.
- This change in conditions will also have effects on organisms which serve as food for fish. The river benthos, the main source of food for the fish, will disappear. The fact that there will be a considerable drawdown of the reservoir will create unfavourable living conditions for such organisms.
- The dam will be an obstacle to migrations; however, it has to be seen that major migrations, if there were any , have already been interrupted by Nurek dam 30 years ago.

Some more thought will have to be given to the possible development of Rogun reservoir, but there is a high probability that it will be similar to the development described for Nurek reservoir.

11.4 Next Steps

Additional field work will be carried out in July and August; this will include Vakhsh river upstream of Rogun dam site as well as Nurek reservoir, in order to get a better picture on species actually present in the project area.

It is probable that Rogun reservoir, and its fish fauna, will develop in a similar way as described shortly for Nurek. However, in order to have a better information basis, also for future projects, a good monitoring program of the development of the reservoir would be required. Such a program will be developed and recommended as part of the ESMP in the final ESIA.

12 PROTECTED AREAS

Tigrovaya Balka Nature Reserve and any other protected area or habitat important for biodiversity conservation (even if not legally protected) that might be affected by the Project, or that might be used in any way for mitigating impacts, if required.

12.1 Theoretical Considerations

Impacts of a project on protected areas have to be evaluated very carefully, mainly for the following reasons:

- Protected areas have a legal protection status, and interference with them in any way that is not in compliance with this legal protection therefore has to be considered as an illegal activity.
- Protected areas have been declared as such because they contain some exceptional values (e.g. in terms of biodiversity) which need to be protected. Impacts of a project might contradict the main protection aims of such an area, e.g. by interfering with habitat conditions on which the biodiversity of this area depends.

For both reasons, potential project impacts need to be identified, and mitigation measures need to be taken in case of adverse impacts.

12.2 Protected Areas in Tajikistan

Article 13 of the Constitution of the Republic of Tajikistan states: “Land, its minerals, water, air, flora and fauna and other natural resources are the exclusive property of the state and the state guarantees their effective use in the interests of the people. “

In accordance with the Law of the Republic of Tajikistan "on specially protected natural territories" there are the following categories of protected natural areas:

1. state natural reserves, including state biosphere reserves;
2. state national parks of the republic (national parks) and parks of local importance (provincial parks);
3. state nature reserves of the republic and of local importance;
4. public monuments of nature of the republic and of local importance;
5. environmental and ethnographical zones:
6. dendrological parks and botanic gardens;
7. natural, therapeutic areas (health resort zones);
8. natural recreational areas.

Protected areas include natural complexes and objects that possess exceptional environmental, historical, cultural and recreational value of national importance

As of January 1, 2010, the following protected areas were officially listed in Tajikistan:

Four state nature reserves, one national park, a nature park, one historical and natural park, three natural recreational areas, more than 20 therapeutic natural areas, and 13 national wildlife refuges; see also map of protected areas in the Figure below.

The total area of the protected areas is 3.1 million hectares, of which the Tajik National Park, located in the Pamir mountains, accounts for 84% (2.6 million ha). The area of all nationally protected areas comprises 22% of the country.

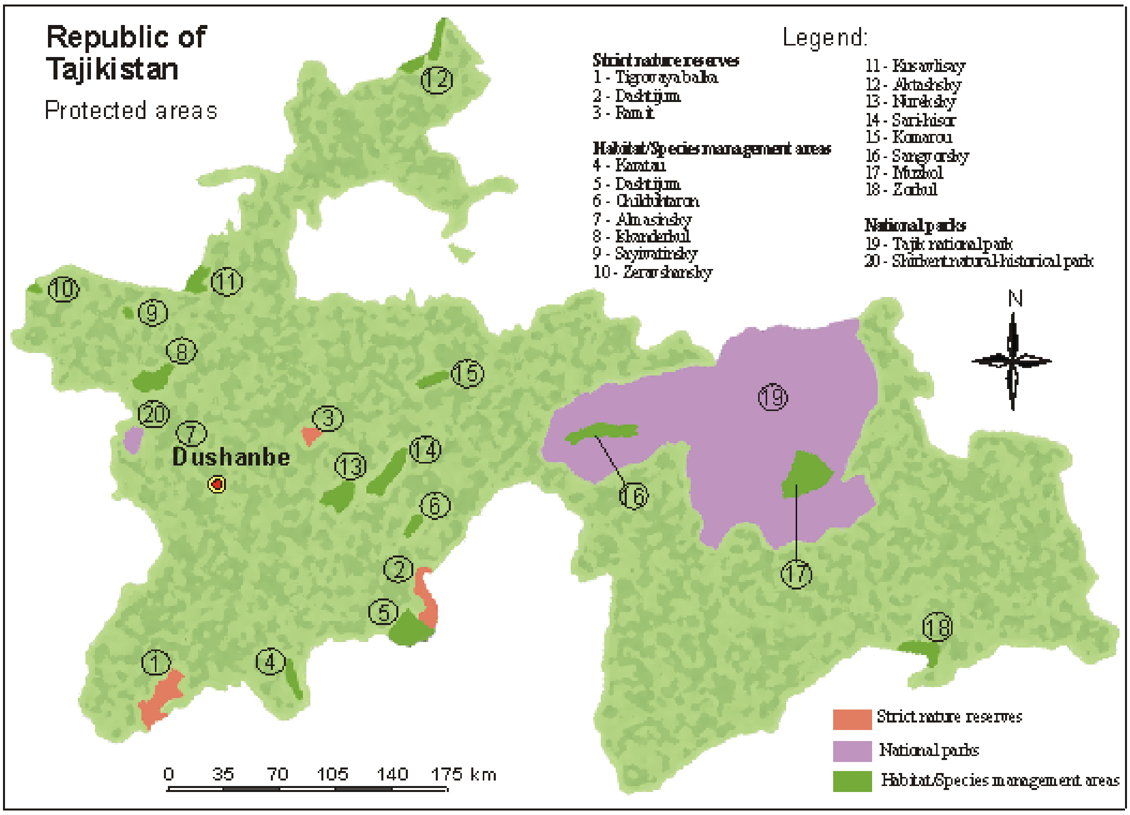

Figure 12-1: Protected areas of Tajikistan

Source: SOE 2000

12.3 Tigrovaya Balka State National Reserve

The Tigrovaya Balka State National Reserve is located in the lowermost part of the Vakhsh river basin, down to its confluence with Pyanj river (where these two rivers from Amu Darya), close to the border with Afghanistan. It was created by decree No. 1163 of the Tajik SSR on November 4, 1938. Its main objective was the conservation of the unique tugai complex and of the animals living in it. Tugai is the name of a specific type of floodplain habitat in desert areas of Central Asia; it is characterised by a groundwater level close to the surface, which conditions a specific vegetation type composed of a number of specialised tree species, reeds etc. It is also a habitat for many species of animals. 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 place where the Caspian tiger lived, which finally disappeared 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 of animals - the Bukhara deer, black and golden pheasant, gazelles, the striped hyena and other species.

The climate is continental and arid. The average annual temperature is +14 to +17°C, the temperature of the coldest month (January) is + 2°C, the one of the hottest (July) 32 to 38°C Temperature in July sometimes reaches up to 48°. Length of 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, up to 70% falling in winter and spring months, usually in the form of rain.

The reserve contains about 20 lakes of different size; their water is poorly mineralised, with about 1.92 to 4.67 mg/l (check!). Besides 438 species of vascular plants, within the reserve there are about 30 species of reptiles, 34 species of mammals, 2 species of amphibians and 150 species of birds. It is one of the few remaining habitats of the Bukhara subspecies of the red deer or Hangul (*Cervus elaphus bactrianus*).

Main threats for 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.

As every floodplain habitat, it depends directly on the dynamics of the river forming this plain, i.e. in this case Vakhsh river. These river dynamics are made up by the amount of water flowing, but to a very great extent also by the seasonal distribution, and especially by seasonal floods. The area is of concern for the Rogun ESIA, since this Project can influence the river discharge pattern in this area, which in turn would have an effect on this fragile system. For this reason, it must be included in the study.

12.3.1 Effects of the Vakhsh Cascade

The first HPP (Perepadnaya HPP) on the Vakhsh river was put in operation in 1959, followed by Golovnaya HPP, Central HPP, Nurek HPP and Baypazin HPP. Nurek HPP, which is operating since 1972, had the strongest impact on the discharge regime of the Vakhsh (see Section 8.2), the other power plants are ROR schemes with little regulating capacity and therefore little influence on river flows. The discharge pattern of the cascade has changed the natural discharge regime of the Vakhsh river from a highly variable to a more uniform flow, and, as has been shown earlier, has reduced the peak flow in summer. Furthermore, the sediment was trapped behind the dams (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. In addition to the impact of the HPP cascade water from the Vakhsh river is used for irrigation and as drinking water. This cumulative impact has lead to a reduction of overall water quantity, and especially of summer flows, and to a lowering of the groundwater table. In addition, the reserve received drainage water from irrigated areas contaminated with fertilizers and pesticides, and the salinity of the soil increased.

Summer floods are essential for the dynamics of floodplains and for maintaining the highly specialised ecosystem, which is adapted to these condition. Floods flush out the soil, which is leading to a desalination, they bring new alluvions, they destroy periodically a part of the vegetation, which is important for maintaining the characteristic pioneer vegetation types, and they prevent the invasion of plants from surrounding drier areas, which otherwise would outcompete the characteristic tugai vegetation. Under present conditions, this dynamic is no longer maintained. The main visible effect, due to lowering of the groundwater table and lack of inundation, was the continuous decrease of the water in the characteristic lakes of Tigrovaya Balka (which are in reality old parts of the river bed which were cut off from the main stream).

12.3.2 Management Projects in Tigrovaya Balka

In 1975, due to the changes in the natural runoff, a special resolution was taken to develop measures to preserve and improve the protection of fauna and flora in Tigrovaya Balka. Several scientific and management projects started in Tigrovaya Balka in the 1980ies. These projects came to a halt after the end of the Soviet Union.

The first project with WWF participation started in 1998. The recent project “Integrated River Basin Management and Nature Protection in Tigrovaya Balka” funded by WWF – Norway started 2007. The main aim of the project is to establish long-term plans to conserve and restore the tugai ecosystem of Tigrovaya Balka. The main tasks are

i. strengthening environmental governance,

ii. conservation and restoration of the tugai freshwater ecosystem of Tigrovaya Balka and

iii. develop strategies for sustainable use of Tigrovaya Balka providing sustainable livelihood.

The work for point ii) includes among other things, to ensure that the floodplain receives the water necessary to recover as far as possible. Canals between the lakes have been cleaned, additional canals have been built and lock and pump stations have been implemented to allow the water to pass from one lake to the next and to provide water with low salinity from the Vakhsh river to enter into the ecosystem.

The map on the following page shows the main actions taken by the WWF to recover the ecosystem.

The pictures in Annex 20.12 show the effect of these measures. the water level of the same lake from the same position in the Tigrovaya Balka before and after implementing the first measures (cleaning of canals) have been implemented.

12.4 Next Steps

It is not the role of the ESIA to take over the work under way by the WWF. However, since the river regime is the essential factor in driving the dynamics of this fragile ecosystem, and since Rogun HPP could have an additional impact on it, water requirements of this system will be analysed in more detail, and proposals will be made, if required, to improve the situation. One environmental mitigation measure could be to assist the WWF in its efforts for maintaining this ecosystem. It remains to be seen in which way this could be done. One possibility could be to set up an environmental discharge pattern which would include irregular artificially generated floods (with a return period of 5 to 10 years) in an irregular pattern, which would inundate the entire area and which could locally dislocate sand and river banks.

For the ESIA, the water requirements for maintaining the specific ecosystem of Tigrovaya Balka will be assessed, both in terms of quantity and yearly distribution, and this will be used as a basis for proposing adequate mitigation measures.

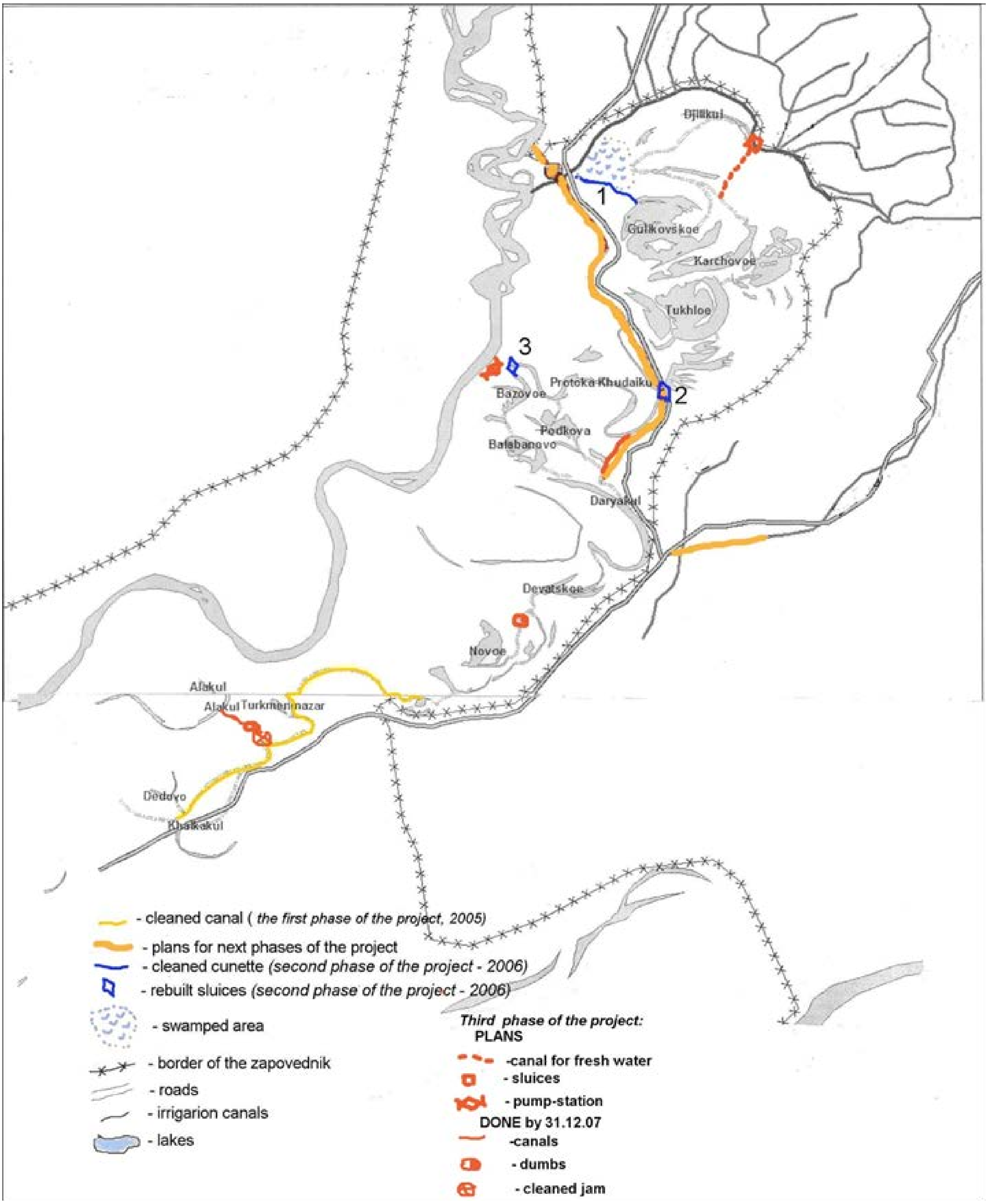

Figure 12-2: Actions taken by the WWF to recover the tugai ecosystem

Source: WWF Russia

13 SETTLEMENTS AND POPULATION

13.1 Theoretical Considerations

Involuntary resettlement triggered by development projects has become a topic of increasing importance. While such a resettlement can be caused different kinds of projects, it is often of special importance in dam projects, due to the fact that reservoirs often occupy a considerable area, and that human populations have a tendency to be concentrated along rivers. The main reasons for these concentrations are the presence of fertile alluvial soils in river valleys, as well as the fact that rivers provide water, food (fisheries), and transportation routes (directly, in case of navigable rivers, or by roads following the valleys). This can create major conflicts between projects and the interests of the local population.

The World Bank played a major role in formulating policies as guidelines for such resettlement efforts. The core point of all such policies consists in the principle of fair compensation for lost assets. The aim of any resettlement program must be to prevent project affected persons (PAP) from impoverishment due to the project. As a minimum, after resettlement such persons should be at the same (economic) level after the resettlement as they were before, and if possible their situation should improve (benefit sharing). These principles are by now generally accepted standards.

13.2 Specific Conditions of Rogun Resettlement

The conditions for resettlement for Rogun HPP are rather unusual due to the history of the Project. Resettlement started in the 1980ies, when construction work for Rogun started. In 1991, after independence, all work, including resettlement, came to a halt. The civil war then caused considerable and largely uncontrolled movements of populations, and during this period some people who had been resettled returned to their original places. Recently, with the efforts for finally implementing Rogun HPP and an increase in construction activities on the site, resettlement activities were resumed. Our efforts so far have revealed that it is almost impossible to receive reliable data on these past processes, and data received are often contradictory.

In the beginning of 2011, a new organisation was put in place. The official name of this organisation, translated from Tajik, is “Directorate of the Flooding Area of Rogun HPP”; in this report, and in the ESIA, it will usually be referred to as the Resettlement Unit (RU). This organisation is making a big effort to get the process under way again, and to clarify the situation.

13.3 Resettlement for Rogun HPP

13.3.1 Resettlement Done in the Past

When resettlement started in the 1980s, more than 5’000 people were removed from the construction area and to make way for construction of the new Rogun town. Some 3’000 people were removed from the reservoir area, mainly the Chorsada settlement, and were resettled in Dangara District; however, all the families returned to their original villages during the civil war, partly also due to unfavourable climate conditions and insufficient services. An unknown number of people were resettled locally at elevations below and above 1,290 m asl.

From 1986 resettlement began to make way for the construction of Rogun HPP and at this time Tajikistan was not yet independent. The project itself was from 1978, and the confirmation of the project was issued on 27th December 1980. From 1984 -1992 resettlement started in earnest.

321 families were resettled to Dangara and Nurobod. However, during the civil war part of the population came back to where they had been removed from, and others went elsewhere. According to the speech of the President, 123 families were resettled during the Soviet period. To date, from the 123 families, 12 families are living in Dangara.

After independence according to the Law, Art. 47, resettlement began again from the reservoir area. However, since the start of the ESIA studies in agreement with the World Bank, no more resettlement is taking place except for the six villages which are either in the construction site or in the risk zone area (Stage 1 villages, see Section 13.6). The villages are specified in the next subsection of this chapter.

13.3.2 Resettlement Presently Under Way

Areas have already been identified for relocation of affected people and these include Rogun, Tursunzade City, Rudaki District, Nurobod District and Dangara District of Khatlon Region. These sites have been chosen by the Government as decreed in law, Article 47.

In 2009, an approximate total of 3,427 persons were relocated from Nurobod District to the following identified districts and towns: Dangara district, Darband Town, and Rudaki District.

Till June of 2010, the Resettlement Unit (RU) has resettled 1’038 families. After June 2010, in agreement with the World Bank, resettlement stopped. The RU is now constructing the infrastructure for the resettled; resettlement has been stopped except for the six villages that are located within the “risk zone”, i.e. within or n close proximity to the construction site, or that are going to be submerged in Stage 1. These are Tagi Kamar, Talkhakchashma, Tagi Agba, Kishrog, Mirog, Sech and Chorsada. Out of these villages, only Chorsada will be submerged in Stage 1 (reservoir level at 1’110 m asl).

For Rogun town 175 families were to be resettled in 2009, while in Nurobod District 863 families were foreseen to be resettled in 2009 and 2010. The relocation of people from the two areas is behind schedule. This is mainly due to the fact that resettlement sites are not yet ready for occupation; the World Bank insisted that infrastructure in these sites needs to be in place before people will be moved there. Those from Rogun will resettle in Tursunzade, while those from Nurobod will be settled as shown in the Table below

Table 13-1: Distribution of HH resettled from Nurobod

To \ From	Nurobod
Dangara	187
Tursunzade	180
PGT Darband	265
Rudaki	231
Total HH	863

13.3.3 Resettlement Foreseen for 2011

The most recent census is from 2010 and covers 5 villages. These villages were supposed to be resettled in 2011. To date the RU has not carried out any surveys.

Table 13-2: Villages in Rogun District to be resettled in 2011

Village	Total persons	Households	Families	Relocation site
Tagi Kamar	69	34	35	Tursunzade
Talkhakchashma	20	2	18	Tursunzade
Tagi Agba	11	6	5	Tursunzade
Kishrog	56	31	25	Tursunzade
Mirog	3	3	-	Tursunzade
Sech	9	3	3	Tursunzade

A more detailed breakdown in number of households and population to be relocated to the new sites is found in Annex 13.

As of now the land put aside for resettlement is largely sufficient for the villages to be relocated in Stage 1.

In effect, the above villages are not yet installed in their new site, as the RU is preparing the new site in terms of constructing houses and putting in place the necessary infrastructure. For general infrastructure that is tied to the national network, e.g. roads and transmission lines that will be linked to the new sites, these are not under the responsibility of the RU, but of the concerned ministries, e.g. roads (Ministry of Transport) and electricity (Ministry of Energy).

13.4 Resettlement Audit

13.4.1 Resettlement Sites

Visits to the selected resettlement sites on the 2nd, 3rd and 6th June 2011 have shown that infrastructure is being put in place. One of the most important, to be put up first in all the sites visited was been electricity, where an increased number of transformers has actually boosted the host communities’ energy supply.

Other equally important infrastructure already up is water supply for drinking and for irrigation. However, drinking water supply was found not to be constant in Rudaki, where the majority of Chorsada residents will be allocated. This allegedly should be rectified by 10th of June. During periods of erratic drinking water supply, the host community nearest to the site (500 m) has to share its water and this has not gone down very well.

Roads have also being constructed, and in future schools and health centres will be put up at each of the new site. The host community schools and health centres are at present serving the few relocated settlers. To date no increased pressure has been felt at the existing facilities. Land has been found to be ample for both cultivation and pasture at all the new sites.

The following paragraphs provide a short description of the resettlement sites which are not located within the project area itself.

Rudaki

This is the site for the Chorsada villagers; it measures 38 hectares and is far from completed. Only four families have moved there and are already living on site. 22 families are in the process of constructing their houses. Rudaki will be divided into four settlements, and so far Settlement 1 has most of its infrastructure in place apart from the school and health centre. The nearby school serves the resettled families well. The planned school will serve 640 pupils and this will cover settlements 1, 2 and 3. The 4th settlement will have another school, also catering for 640 pupils. A Table showing the four settlements planned for Rudaki and the number of families for each settlement is shown below:

Table 13-3: Status of new settlement sites in Rudaki

Settlement	Families	No. of transformers in place for electricity	Other infrastructure in place	Status
First	33	1	11 water points, roads but still to be tarmacked	4 families in place, 22 families building houses
Second	63	2	Not in place yet	Only land defined
Third	80	2	Not in place yet, but school & health centre to be built in July 2011.	Only land defined
Fourth	71	2	Not in place yet, but will have own water supply system.	

Note that Rudaki is the site that will receive most of the resettlers from Chorsada, who had been resettled in the earlier years but went back to their old villages due to various factors, e.g. hot climate too, civil war, land not favourable for cultivation, etc.

Dangara

Dangara, located in Lolazo Jamoat, has an area of 39 hectares, and 70 families are already living there. This site is meant to serve 250 families, out of which 187 have received their land. House construction is under way, and 119 houses are ready for occupation. Most infrastructure is in place and roads are tarmacked, 12.3 km in total. A railway station is nearby. Electricity is in place with 5 transformers providing 430 KV. Drinking water is present with one water point serving 2 houses. Irrigation water canals are present and functioning.

Tree planting and paths are planned for the site. A trading centre is planned at the same site as the school and health centre. The present school is big enough to cater for both the host community and newcomers. A nearby health centre was visited; it is staffed with a doctor and 4 nurses. The HC deals with first medical help, serious medical cases are referred to the main hospital in Dangara. Most of the medical treatment offered covers “mother and child” health services including childbirth, first child check up, vaccinations, immunisations etc. At present no additional pressure is felt at the facility due to the new settlers.

The site has plenty of land for wheat cultivation which is already in evidence. Already 14-15 hectares of land has been taken over by the present resettlers for cultivation. As a general rule 0.15 hectares is set aside for the family gardens and other land for cash crops such as wheat, cotton, etc. has already taken up 2.5 hectares. Pasture land for livestock is ample and found on the opposite side of the railway line. Three toughs are in place for water for the livestock. The host community confirms that there is plenty of land and new hands are needed to work the land.

An old settler from 1988 recounts how the government built everything for them, trees were planted and they chose the place themselves mainly due to the open space, plenty of water and the massive land available. He further recounts how he stayed on because the weather was good for his father who had asthma and is now breathing well. The interviewee is now a proud owner of a combined harvester and he cultivates 25 hectares of land, where 20 hectares are for cotton and the other 5 for other crops. He stresses that “here land is in plenty”.

A free economic zone is planned where a plant for juices is to be constructed. A mosque is also being constructed.

Tursunzade

Tursunzade has 40 hectares of land set aside for new settlers. The site is planned for 355 families. From Nurobod 180 families will move here and from Rogun 175 families. The water tower in place demarcates the families from Nurobod and Rogun, with land on the western side of the water tower housing the Nurobod migrants, on the eastern side the Rogun migrants. 27 houses have already been constructed and are occupied. Each homestead has a characteristic vegetable garden (maize, cabbage, potatoes, tomatoes, etc.).

Infrastructure is in place, with roads measuring 7 km in total. Four transformers are in place supplying 1’000 kWh. A school that will cater for 1’176 students for both primary and secondary levels is to be built. Water points are in place along the road, whereby each water point serves two houses.

In the vicinity of the site, the big aluminium smelter, by far the largest employer in the area, offers employment opportunities to new comers. There is also a chicken factory which however needs to be rehabilitated.

13.4.2 Approach

A Focus Group Discussion (FGD) questionnaire was designed. This was used in the villages to be relocated, and it will also be used in the host villages. Interviews with people who were resettled and returned to their old village later on, to be now resettled again, can give an idea of why resettlers returned to their original villages, as they have experienced the resettling and can point out what went wrong.

So far, FGDs have been carried out in the villages to be relocated in Stage 1 (see Section 13.6). In these villages three groups were formed, namely, men, youth and women. There were some villages which were found to be too small, and 2 FGDs were then carried out (men and women).

A household questionnaire was also designed and a sample of the population in the 6 affected villages (Stage 1 villages) was interviewed (see Section 13.6.2).

The HH questionnaire covered:

- Personal data
- Data on land and house acquisition
- Sanitation, water and health
- Compensation
- Household livestock and agricultural output
- Energy
- Household income and expenditure
- Benefits and problems associated with Rogun HPP

General questionnaires on affected villages and host communities were also used to gather information on the following:

For the villages to be resettled:

- History of the village
- Population, ethnic groups and number of households
- Socio-economic activities
- New economic activities villagers wish to embark on
- Land use and vegetation
- Infrastructure, both social and economic
- Description of social support network in the village
- Leadership structure.

For the host sites:

- History and location
- Socio-economic situation
- Land use and agriculture
- Social infrastructure in order to assess the utilities and services provided

- Other infrastructure (Markets, roads, electricity, telecommunications)

The surveys will be carried out in the next phase of the study.

13.5 Resettlement: General Conditions

13.5.1 Legal Basis

Resettlement in Tajikistan is regulated by the national resettlement policy entitled

Regulations on Domestic Migration Procedure in the Republic of Tajikistan

(Resolution No. 467 of Oct. 1, 2008; see Annex 13.4.2).

Specifically for Rogun HPP, there is an additional text,

Resettlement of the Population of Rogun Town and Nurobod Rayon from Zones of Submersion of Rogun Hydropower Plan

Resolution No. 47 of January 20, 2009: see Annex 13.4.1).

A gap analysis of these texts as compared to WB requirements remains to be done. However, one important point can already be mentioned, namely, the fact that Resolution 467 (2008) refers to voluntary resettlement, a condition which is clearly not given in the case of Rogun HPP:

13.5.2 Implementing Structure

In general, the country coordinating authority on internal (voluntary) migration is the State Agency on Social Protection, Employment and Migration of Population, Ministry of Labour and Social Protection of the Republic of Tajikistan.

Regarding the reservoir area in Rogun HPP, the Government of the Republic of Tajikistan adopted Resolution No. 47 (see above). In order to carry out the resettlement of population from this zone, the state agency “Directorate of the Flooding Zone in Rogun HPP" was created on the base of the Resolution No. 546 of the Government of the Republic of Tajikistan on 27.10.2010. In accordance with this Resolution this Directorate is independent of the governance structure of the Open Joint Stock Company "Rogun HPP." Aimed at implementing its activities, the Charter of this directorate was approved by Resolution No. 3 of the Government of the Republic of Tajikistan, as of 06.01.2011. The director of this agency is appointed by the President of the Republic of Tajikistan. The current Director, Mr. Ramazan Zarifovich Mirzoyev, was appointed to this position on November 10, 2010.

Note: the official title of this important agency, in its English translation, is the “Directorate of the Flooding Zone in Rogun HPP". However, when referring to impacts caused by the project, in English “flooding” is not the appropriate term. “Flooding” is a sporadic, short term event caused by exceptionally high river flows which cannot be contained within the normal river bed and which therefore will flood or inundate adjacent areas of land, often causing considerable damage. When the river flow goes back to normal, the water retreats and the flooded areas are no longer covered by water. In the case of a reservoir, however, the filling of a reservoir is neither a catastrophic event caused by exceptionally high flows, nor a temporary situation which will be reverted to its original state after a certain, normally rather short period. On the contrary, it is a well planned and controlled process which will then be, for the duration of the life span of the dam (which can be 50 to 100 years or more), the normal situation. In this case it is more appropriate to refer to "submersion" rather than to "flooding" or "inundation", and this term is used in the present report (and will be used in the ESIA). The Directorate in charge of resettlement, in the ESIA study, is usually referred to as "Resettlement Unit" (RU).

13.5.3 Principles for Compensation

In accordance with the Resolutions mentioned above, as a compensation for lost assets families that have to be resettled have a right to the following benefits

- When the decision on relocation has been reached to move a family to a new place, within 10 days 3000 TJS is allocated for the construction of the new house as a privileged credit, 100 TJS is allocated to the head of the family and 50 TJS is provided for each family member as a lump sum. In accordance with paragraph 30 of the Resolution on Internal Migration, this privileged credit will have to be repaid by migrant families within 5 years, whereby 50% must be paid by the migrant and the remaining 50% by the republican budget. The payment of the privileged credit and other benefits is done by the Savings Bank of the RT «Amonatbank».
- Based on the resolution, the evaluation commission informs migrant families about the cost of their houses and other property, evaluated according to the market price. The payment for houses, equipment, prolific trees, agricultural crops and personal belongings or property has to be done in line with the Charter of the RU.
- The financing of transportation of migrants from the old village to the new site is assured by funds allocated specifically for this purpose from the republican budget; this issue is in the scope of the Ministries of transport, health and internal affairs.
- The migrant family receives an equivalent piece of land in the resettlement area. The RU is responsible for drafting acts on land allocation.

13.5.4 Definition of Household and Family

In resettlement planning, the unit to deal with is the household (HH), which is a unit of people usually (but not necessarily) with family ties living together and having a common economy. In the case of Rogun (or in Tajikistan in general) families are counted in addition to households. The term "family" denominates a nucleus family, i.e. a married couple with its children. A household can contain several families (usually the married sons of the head of the HH with their wives and children). The official resettlement lists therefore contain households as well as families.

The reason for this is compensation and the way it is allocated. In the case of a household, the title for the house is in the name of the head of the household, and compensation in terms of land for the new house and the house itself as well as any other compensation to be made will be made in his name. An additional family living within the HH, e.g. a son with his wife and children, is not entitled to compensation. However, when being resettled such a family can apply for creating a household of their own. In this case, this family will be given a parcel of land for building its own house in the new site; however, the cost for actually building the house will be its own responsibility (as would have been the case if this family had built its own house in the original village). This procedure is according to Article 11 of the law on resettlement (No. 467 of 01/01/2008).

13.6 Stage 1 Resettlement

13.6.1 Definition of Stage 1

According to the TOR for the ESIA, a Resettlement Action Plan has to be prepared for the Stage 1 villages, i.e. the villages which will be affected by the reservoir at an FSL of 1’110 m; for the definition of Stage 1 see Section 3.6).

There is only one village, Chorsada, which will actually be submerged at this stage. However, a number of villages, although above this level, are located either within the construction area or very close to the dam, i.e. within the so-called risk zone. They also need to be relocated with priority, and they are included in Stage 1. These villages are listed in Table 13-4. The villages within the construction site are Tagi Kamar, Tagi Agba, Talkhakchasma and Sech, all situated in Sicharog Jamoat in the District of Rogun. The lands for cultivation and pasture for the villages will also be affected, as will the roads and paths. Two villages, Kishrog and Mirog, are located downstream of the dam, but within the risk zone of the construction site.

In these villages, resettlement has started already. during the first visits of the Consultant to these sites it was concluded that, given the situation, the resettlement process should not be interrupted, but should continue. As the FGDs showed, people are already in a rather difficult situation, since they know that they will be relocated, and since they experience restrictions when it comes to repair or maintenance work for their houses. Interrupting the process now would only increase their problems.

This means that the development of Stage 1 RAP has to face the situation that it is being developed under quite special conditions, namely, as part of and in parallel to an ongoing resettlement process.

Table 13-4: Villages to be resettled in Stage 1

Village name		elev. m asl	No. of HH	No. of pers.	Observation
Tagi Agba	Таги-Агба	1150	7	57	in construction site
Talkhakchashma	Талхакчашма	1240	47	384	in construction site
Sech	Сеч	1150	6	42	in construction site
Tagi Kamar	Тагикамар	1150	37	284	in construction site
Kishrog and Mirog	Кишрог, Мирог		37	335	d/s of dam
Chorsada	Чорсада	1107	155	947	submerged in Stage 1
Total			**289**	**2049**	

13.6.2 Results of Household Survey

13.6.2.1 Sampling

A household survey was conducted in the seven villages which are subject to relocation at the Stage 1 of Rogun HPP. Kishrog, Mirog, Sech, Talkhakchashma, Tagi Agba and Tagi Kamar villages near Rogun town are in the risk zone (construction area), and Chorsada, in Nurabad rayon, is the only village which will be submerged in Stage 1, at an FSL of 1110 m asl.

Table 13-5: Household sampling

Rayon	Jamoat	Village	Number of households	Sample size	% of households
Rogun	Sicharog	Kishrog	31	7	22.6
		Mirog	7	3	42.8
		Sech	7	2	28.6
		Talkhakchashma	40	9	22.5
		Tagi Agba	6	4	66.7
		Tagi Kamar	33	5	46.0
Nurabad	Khakimi	Chorsada	142	15	10.6
Total			**266**	**45**	**17.0**

The sampling of households was carried out with regard to the number of households in each village. A representative sampling size for the qualitative surveys was considered as being 10-15% of the total population. 45 households or 17% of the total of 266 households were covered by the survey.

13.6.2.2 Socio-demographic Indicators

Age Structure

The results of household surveys show that the population in the Stage 1 area is mostly Tajik, they are Muslims and their native language is Tajik. The average household size is 7.5 persons. According to gender, there are 46% women and 54% men. As for age groups, 33% of the sampled population are children under the age of 14, including 12% of children under 5 years old. The share of young people in the age of 15 to 25 years is 23%, and 16.5% are in the age class of 26 to 35 years. 13% are between 36 and 50 years, 8% between 51 and 63 years, and 6.2% are over 63 years. The share of the working age population (15 - 63) is just over 60%.

Marital Status

In the sample in average there are four families per household. 18% of the adult population are unmarried, 76% are married, 2% divorced and 4% are widows or widowers.

Occupation

The level of employment of the population is relatively low. The overall level of unemployment is 8.2%. However, 83.2 percent of the women (equal to 40% of the total population) are housewives, not considered as being unemployed. The unemployment ratio of men is almost 15%. Concerning men, Rogun HPP is the most important employer, 32.1% of the male population working on Rogun construction site. Around 24% are involved in labour migration to the Russian Federation, and 15% are unemployed. The major part of the women (83, 2%) stay at home as housekeepers, and only 6% bring income, received from official employment.

Table 13-6: Employment of the adult population (in %)

Type of activity	Total population	Including	
		Men	Women
Student	5.2	8.2	1.0
Teacher	1.4	2.7	
Entrepreneur	2.4	4.6	
Labour migrant	12.8	23.8	1.0
Retired	11.0	13.8	8.9
House keeper	40.0		83.2
Unemployed	8.2	14.8	1.0
Working at Rogun HPP	19.0	32.1	4.9
Total	100	100	100

There is a risk that due to resettlement some of the men currently employed at Rogun will lose their job due to the long distance between construction site and the relocation site. Therefore it is necessary to take measures to ensure their employment. Rogun HPP actually has a policy of working in shifts (2 weeks working, two weeks off) for employees not living in proximity of the site, and resettlers can get employment according to this.

Internal Migration

Among the heads of households interviewed, almost everyone noted that they have been living in this locality for more than 5 years. Only 15% of the total number of household members are women coming from other places, moved here when they married an inhabitant of their present village. The majority of household members were born in the village where they live.

Access to Education Services

The level of education among the adult population covered by the survey is relatively low compared with the average at the country level. So, 3% of the total number of household members over 14 years old do not have any education, 18% have primary education, 69% have secondary education (mostly 9 grades) and only 10% have vocational secondary and higher education. As for the gender aspect, the level of education among women is lower as compared with men. 4% of the total number of women do not have any education; around 26% have only primary education and only 2.7% have vocational secondary and higher education.

Table 13-7: Level of education of adult population (over 14 years old, in %)

Level of education	Total population	Including	
		Men	Women
No education	3	2.3	4.0
Primary	18	12.5	25.7
Secondary	69	70.5	67.6
Vocational secondary education	5	7.7	0.9
Higher education	5	6.9	1.8
Total	100	100	100

The main reason for the low level of education in these villages is poor access to education facilities. So, there is no school in three out of seven villages covered by the survey (Sicharog, Tagi Agba and Mirog), there is only elementary school in two villages (Kishrog and Talkhakchashma) and there is a secondary school only in Tagi Kamar and Chorsada villages. The distance to schools, both primary and secondary, from the location of residence reduces the level of public access, particularly for girls, to complete and good quality education. Over 70% of the total number of respondents stated that the school is more than 1 km away from their location, including 20% of residents who said that the distance is more than 5 kilometres. The lack of transportation and dangerous mountain roads make education for certain part of the population, especially for girls, inaccessible.

Housing

12 out of the 45 households included in the survey reported that they built their houses by themselves, while 33 inherited them from their parents. As for the type of houses, 38 are permanent buildings and 7 are temporary buildings. Regarding the type of roofs, 2 are covered with thatch material, 30 with corrugated iron sheets, 3 with roof tiles and 10 with asbestos slate. In general, villagers prefer to use modern materials for their roofs.

The main material for building walls was clay (31 houses). This is mostly due to the cheap price of this material and its availability at the construction sites. Wealthier households (there were only 4 of them) used cement blocks and stones for the construction of their houses.

The type of the floor indicates a relatively low standard of living of the population in the surveyed villages. Only 2 of the total number of households have wooden floors in their houses, 12 have cement, while the majority, 31, have clay floors. Almost all windows have glass.

The average number of rooms per house is 3.7. 46.6% of the total number of surveyed households have 2-3 rooms; 31.1% have 4 rooms and 22.3% have 5-6 rooms. With an average number of 8 people per household, on average there is one room per two people. The concept of bedrooms in rural households in Tajikistan is somewhat different from Western standards. In the Tajik rural households, where the number of people is relatively high, almost all the rooms can be used as bedrooms.

Water and Sanitation

Toilets: all but one of the surveyed households use the so called rural toilets (cesspit with cover). When the pit is full it is covered with earth and a new pit is excavated. Usually, the toilet is located near the margin of the house lot.

Garbage disposal: in the surveyed villages there is no system of centralized garbage removal. 67% of the of the respondents noted that they have a special disposal pit for garbage disposal. When the pit is full, they cover it and make a new one. 24% of the respondents reported that there is a municipal pit available, where they dispose of all the garbage, 9% of respondents mentioned that they mostly burn it. As the survey showed, municipal pits are usually located outside of the village and the people maintain them for sanitation by means of collective work ("hashar").

Access to drinking water: 16 of the total number of surveyed households(45) have tap water as the source of drinking water, 11 use delivered water, and 18 use springs as their source of drinking water. In Chorsada village there is tap water available; in Sech and Talkhakchashma village residents use delivered water, and villagers in Kishrog, Mirog and Tagi Kamar use spring water. In Tagi Agba, a quarter of the population mostly uses delivered water and the rest has access to spring water. It is necessary to note that although respondents of Chorsada village mentioned that they use tap water, water comes from a spring.

Table 13-8: Access to drinking water

Villages	Source of drinking water (in %)		
	Centralized water supply system	Delivered water	Spring water
Kishrog			100
Mirog			100
Sech		100	
Talkhakchashma		100	
Tagi Agba		25	75
Tagi Kamar			100
Chorsada	100		

60% of respondents noted that the source of drinking water is near their houses; one household has a distance of less than one kilometre, and 38% of the households have it at a distance over one kilometre. More than 33% of the respondents noted that they face difficulties with access to drinking water in draught periods, mostly in summer. This is the case mainly in Talkhakchashma, Sech and Kishrog. In case of a shortage of drinking water, villagers initiate the delivery of water by vehicles (water carriers). Respondents mentioned that the delivery of drinking water by water carriers is free of charge.

Access to Medical Services

98% of the respondents said that they use modern medical services if someone gets sick, and they refer to medical facilities. Only 15% of the respondents noted that medical facilities are located at a distance less than one km away from the their location, and 85% have it at more than one kilometre. The population mostly receives primary health care in local medical facilities, and in order to get better quality health care they refer to clinics in Rogun, Nurabad and Dushanbe city.

Access to Land

25 of the respondents mentioned that they have land outside of the household for the production of agricultural products. The average size of land per household doing agriculture is 2.47 ha.

Table 13-9: Average size of land per household* (ha)

Land per household	**Number of HH**	**% of HH**
From 0.15 to 0.5 ha	3	12
1 ha	9	36
From 1 to 2 ha	3	12
2 ha	2	8
3 ha	3	12
From 3 to 4 ha	3	12
From 10 to 16 ha	2	8
Total	**25**	**100**

* only HH doing at least some agriculture included in this sample

84% of the total number of surveyed households with land indicated that they use active agricultural land, showing signs of overexploitation of land and reduction of fertility. Only 16% of the respondents indicated that they cultivate land that is not used for agricultural purposes every year (i.e. with fallow periods).

Resettlement Criteria

As mentioned above, when it comes to relocation people have a choice between several locations.

In the surveyed population, 23 of the heads of households reported that they have a preference for relocation and 22 indicated that they still have not made a decision. Among the households that have decided, 12 opt for Tursunzade, 2 for Rudaki (Tepai Samarkandi), 6 for Dangara and 2 for Rogun town.

Table 13-10: Criteria for the selection of the relocation site

Criteria	% of the number of answers
Access to better land	71
Improvement of housing conditions	64
Access to drinking and irrigation water	84
Access to education system	53
Access to health system	42
Improvement of overall situation	20
Improvement of roads and bridges	36
Ability to communicate with family and keep family relations	9

According to villagers in the surveyed villages, important criteria for the selection of the place of resettlement are: access to drinking and irrigation water (84%), better land (71%), better housing conditions (64%), access to education (53%), health services (42%) and improvement of roads and bridges (36%). Only one person among the total number of respondents said that he needs a job in the new place of relocation.

All respondents indicated that they need financial compensation in case of resettlement to the new place of relocation. 91% of the total number of respondents noted that they need to go through training in the new resettlement area in order to learn how to cultivate new varieties of agricultural crops in the conditions of the new climate.

70% of the total number of heads of households indicated that they cannot transport all their property and belongings to the new place of residence. More than 60% of heads of households emphasized that they own fruit gardens and other trees for which they require compensation; around 15% indicated livestock as a property and 9% have trucks.

Agriculture and Livestock

Table 13-11: Main agricultural products

Type of product	Number of HH producing it	% of HH	Annual production (kg)
Potato	43	95,5	1509
Tomato	25	55,5	360
Vegetables	21	47	471
Onion	16	35,5	259
Fruits and nuts	8	18,0	442
Wheat	8	18,0	1156

According to the results of the survey, the population of the villages mostly cultivate potatoes (95.5%), tomatoes (55.5%), vegetables (47%) and onions (35.5%). Only 18% of the population produces fruits and wheat.

91% of the total number of households has livestock. In average there are 3 cows, 7 goats, 1 sheep and 4 hens per household.

More than 93% of the total volume of produced goods is used for own consumption and only 7% is produced for sale at the market. When there is a shortage of food, 64% of heads of households sell their livestock and 27% reduce their rations.

Use of Electricity

All respondents, without any exception, reported that they use electricity. 89% of respondents indicated that they use firewood for cooking and 11% use electricity.

Household Revenue and Expenditures

The survey shows that the salary of household members is their main source of income (51.6%). The relatively high percentage of salary among the resident population in surveyed households is, first of all, related to the fact that a considerable part of the male population is employed at Rogun HPP construction site. On average, two people per household are employed in income generating sectors of the economy. Income generated by agricultural production, including, consumption and sale, contributes with 25% to HH income. Remittances, as a result of labour migration, make up 22.4% of HH income.

Table 13-12: Monthly revenue and expenditure per household

Revenue			Expenditure		
Source	**TJS**	**%**	**Type**	**TJS**	**%**
Agricultural production	788	25.0	Food products	824	64.6
Salary and pension	1’566	51.6	Energy	165	12.9
Remittances	680	22.4	Education	88	7.0
			Health	68	5.4
			Clothes	71	5.6
			Transport	58	4.5
Total	**3’034**	**100**	**Total**	**1’274**	**100**

The major share of HH expenditures is for food (64.6%). Also, a significant share is spent for electricity and heating (12.9%). Expenditures for education (7%) and health (5, 4%) are of less importance. This is, not in the least, related to low access of the population to education and health services.

The data show that HH income exceeds expenditures by a factor of 2.4. Once relocated, villagers might have to increase their expenditures for education, health, transport and, first of all, for purchase of food products. At the same time, income generated by agricultural production might diminish at the initial stage of relocation, and the share of remittances from labour migration might increase. Since the major part of employment is provided by Rogun HPP, income might be lost due to relocation. However, it has t be considered as well that in terms of employment opportunity (and not taking into account Rogun construction site), the resettlement sites offer a greater potential than the present villages.

13.7 Resettlement Plan Outline for Stage 2

A list of villages affected by the Project (Stage 2) is provided in Annex xxx.

For the ESIA Report, a Resettlement Plan Outline will be developed for Stage 2. This work will include, among other steps:

- a continued effort of communication, cooperation and exchange with the RU;
- a sample survey of the affected population in order to get a baseline on their present condition;
- discussions and interviews with inhabitants;
- discussions with local authorities both in the villages to be relocated as well as in the resettlement sites.

13.8 Next Steps

The work for the next steps in the preparation of the ESIA will consist in the following three items, as described above:

- completion of the resettlement audit
- development of the Stage 1 RAP; and
- development of the Stage 2 Resettlement Plan Outline.

14 INFRASTRUCTURE

14.1 Infrastructure to Be Replaced

Two main types of infrastructure have to be considered in the framework of this ESIA, namely:

- Community type infrastructure, like schools, health services, access roads, local administration (hukumat, jamoat), electricity distribution networks, water supply, sewage systems and wastewater treatment plants, etc. This type of infrastructure has to be prepared for each of the villages to be relocated, and this is covered under the general aspect of resettlement planning.
- General infrastructure, to be dealt with at the state level. This concerns mainly the main road which follows the river and which will be submerged to a large part at the moment of reservoir impoundment (Stage 2; only short sections, if any, already at Stage 1).

As we understand, for this second type of infrastructure replacement there is a separate budget, and for the time being it does not seem to be clear whether this will have to be handled by Rogun Resettlement Unit as well, or if a separate entity will be responsible for it. In any case, there is a plan for the replacement of this road (see map in Annex 14). and construction has started. It remains to be seen what has already been done so far for constructing this new road.

14.2 Main Road

The reservoir will submerge a substantial part of the main road (M 41) leading from Dushanbe to Garm (Rasht) and to GBAO. In Stage 1 (FSL at 1110 m asl), only a small part of the road, with one small bridge, will be affected, near the village of Chorsada, the only village which will be submerged at this stage. However, at the final stage (FSL at 1290 m asl), the road from just downstream of Obi Garm up to the upper part of the reservoir, including the bridge now crossing Surkhob river just upstream of its confluence with Obizhingou river (the origin of Vakhsh river) will be submerged and needs therefore to be replaced. There is a road project, and construction has started. The main parts will be (see map in Annex 14):

- a road starting at the existing road just upstream of Obi Garm, along the right bank of the reservoir to Kalainazar; this part of the road contains two major tunnels;
- a long bridge which will cross the reservoir at the narrowest point; on the left bank, the new road will then join the existing roads to Garm and to Kalaikum (GBAO);
- a new road leading through highly mountainous terrain along the upper part of the reservoir (now Surkhob river) to Garm on the right bank of the reservoir;
- a new road originating on M 41 near the existing bifurcation Garm - GBAO, leading along the left bank of the lower part of the reservoir, according to the plan, approximately to the site of Tagi Kamar (a village which will be submerged); this road will provide access to all the villages along the left bank

of the reservoir located at elevations of above 1290 m asl, which therefore will not have to be resettled.

14.3 Conclusions and Recommendations

It is obvious that the submerged parts of M 41, which is an important road, need to be replaced. It is also important that access to villages around the reservoir, which otherwise might no longer be accessible by vehicles, has to be provided.

On the other hand, it is also quite clear that the construction of these new roads, especially given the difficult terrain, can cause considerable impact. One main concern is erosion triggered by road construction. Most of the material mobilised in this way will inevitably end up in the reservoir, adding to its sedimentation. For this reason, it is recommended that a careful evaluation of the road project should be made, with the aim of identifying critical sections in terms of susceptibility to erosion, and for preparing and implementing adequate protection measures where required. This can realistically only be done by setting up an environmental management for the road project, a task which will have to be fulfilled by suitably qualified experts (landscape architects, environmental engineers). Basically, the erosion protection measures which will be proposed in the ESIA for the construction site rehabilitation will be applicable for the road project as well, since the problem is identical.

There are two other points to be considered concerning the replacement of the road, namely:

- The situation of Obi Garm: this village, with is health and tourist infrastructure, is now located on the main road, the entire traffic lading though it. Once the reservoir filled and the new road operational, it will be on a dead end. This means that there will be much less traffic in the village, which for a resort of this type is certainly an advantage. On the other hand, this could mean that shops, restaurants etc. will lose a part of their clients (passers-by who stop there now), and with this a part of their income; if this should be a considerable part of the income, this could lead to a situation which, according to WB standards, would be qualified as an "economic displacement", i.e. a situation where people do not have to be physically relocated because of the project, but lose their livelihood or access to relevant resources. An analysis of the situation will have to be done, and if required measures will have to be taken in order to provide compensation for impacts due to the project.
- The situation of the villages on the left bank of the reservoir: Access for most these village will be improved. However, villages which are close to the dam site will need to go a long way around the reservoir for e.g. going to Dushanbe, Obi Garm or Sicharog. This is not a very satisfying situation. One rather simple solution for considerably shortening the access to these villages, and therefore improving their situation, would be to have a public road crossing the dam crest. This is something that is done on many dams the world over and not in any way an extraordinary measure. It would seem even more logical to do this in case Shurob dam downstream of Rogun would be built (see Figure 8-24) and would need a left bank access.

15 ARCHAEOLOGY

15.1 Theoretical Considerations

Dams and reservoirs can create conflicts with sites of archaeological, historical or cultural importance if such sites are within the directly affected area (i.e. within the construction site, where they may be destroyed by construction activities, or within the reservoir area, where they will be submerged at the filling of the reservoir. For this reason, it is important to know if such sites exist, so that, if required, adequate measures can be taken. Such measures have to be formulated depending on the type and the importance of the site, and can be, among others, the following:

- Excavation and documentation of archaeological sites, transfer of artefacts into a museum.
- Relocation of objects of cultural importance (like e.g. graveyards); such a measure, if required, will have to be planned and carried out together with the local population, and will have to observe the required cultural framework, like e.g. carrying out appropriate ceremonies.
- Reconstruction of buildings of cultural importance, as e.g. places of worship, in an adequate manner in a suitable site (e.g. in the resettlement villages).
- Ethnography: if site specific traditions, local orally transmitted knowledge etc. might be lost due to the displacement of the population, an ethnographic study should be carried out for documenting this knowledge.
- Formulation and implementation of a chance find procedure; this can be of importance mainly for the construction site, where during the construction process objects of importance might be found.

15.2 Results of Field Investigation

The Archaeology expert has carried out a six day field reconnaissance survey to the project area in order to check on known or suspected sites of archaeological or historical interest. Before the site visit, available sources (publications, archives) were consulted in order to identify sites of importance.

The following objects were identified and visited:

1. Obi Garm fortress, originally measuring 35 x 25 m, 3 m high. It was partially destroyed by construction works. From the artefacts found on site it was concluded that it dated from 5^{th} to 7^{th} century.
2. Graveyards in Siacharog, 1^{st} to 3^{rd} century. The majority of the graves were destroyed, only three are left. Diameter of graves is 3 m, and they are covered with stone. In 1998, several of the graves were excavated by an archaeologist (Mr. I. Maslov). The conclusion of that exploration was that these graves do not have any scientific importance.
3. In Chorsada, there was a graveyard dating from 2^{nd} to 1^{st} century BC (Mandelstam 1954). Nothing of it remains.
4. Pumbachi I fortress, located at the entrance to Komsomolobod. Part of it was destroyed due to the construction of houses. According to information dating from

the 1980ies, one part of it, measuring approximately 75 x 40 m, still existed. Pumbachi II fortress was located at the exit of the town. Both stem from the 7th and 8th century AD. Nothing of them remains today.

5. Three dwelling sites from the Neolithic period (younger stone age) were identified and explored in the 1980ies by Mr. I. Maslov (no published results). One was located about 50 m to the south of Pandovichi Poyon. Two similar sites had been discovered around 100 m south and 150 m east of Pandovichi Bolo. Later on these site were destroyed completely by house construction and agriculture.

6. In the eastern part of Pandovichi village there was a hill called Qalacha, measuring 70 by 40 m, dating from centuries 7 - 8 and probably erected as a lookout post. The larger part of it was destroyed during road construction. No exploration of this site has been made so far.

7. The Hamchur fortress dates from centuries 8 - 9. This fortress, a square of about 10 ha, is located in the south-eastern part of Yus village. It is well above reservoir FSL and not in danger from the project.

8. The Darband fortress is located in the western part of Gardanga village, in the south-west of Labijar, in the corridor of the road from Dushanbe to Rasht. The size is 13 ha. The site was explored by Yusufshoh Yakubov and I. Maslov in the 1980ies. It used to be the centre of the Rasht region (from 2nd till 8th century AD). The place was located on the trading road from Gissar to China, Badachshan and India, which was a part of the silk road. The city was divided into three parts: the residence of the king (shoh), the area occupied by the town population, and a suburb outside the town itself. This later place was then occupied by new buildings of Novobod, after an archaeological excavation had been made. The site will not be affected by the reservoir.

9. Shokhon fortress dates from centuries 15-19. It is located 200 m north and east of Mazoni Sir, in the topmost part of the reservoir. It is a square of 34 by 27 m. It is was, as most other fortresses in this area, surrounded by four outer walls. In 1983, Yakubov and Maslov carried out an exploration of the site by excavating an area of 4 y 4 m, which revealed the kitchen with a tanu (traditional oven for baking bread). The place dates from 7th and 8th century.

10. Navodonak is a remarkable place for its beauty. Navodonak consists of two words, nov and don, nov designating a specific structure for retaining water, don meaning spring. Navodonak consisted of three parts:

    a. Bachak fortress (Pisarak), an ellipse, 43 m long and 12 m wide, and originally of a height of 20 m. It stems from the 2nd to 1st century BC.

    b. Dukhtarak fortress, located near Pisarak fortress. It measures 87 by 80 m.

    c. Boturkhon fortress; it was used from 200 BC till 1200 AD, and its size was 50 by 40 m. It consisted of two parts, the shohnishin (residence of the king (shoh), and the shakriston, the dwellings of the population). This latter part was destroyed during Soviet times, when it was converted to an orchard.

    Like in the case of other fortresses in this area, the foundations are still (at least partly) there, but only traces if anything at all remains visible at the surface. These fortresses are either located just within the reservoir or else just outside in an area where they might be affected by shoreline erosion. For this reason it is recommended to make a detailed exploration of the site before reservoir impoundment. The site and its location in relation to the reservoir will have to be clearly identified.

11. Novobod fortress stems from the 7th or 8th century and was used till the 16th century. With a size of 75 by 40 m it was located at the entrance to Novobod. It was completely destroyed by house construction.
12. Yapoloki fortress was used from the 7th or 8th till the 18th or 19th century. It is located in the western part of Yapoloki village, its size is 148 by 116 m. It was surrounded by protecting walls on all four sides. However, in the 1990ies one person destroyed the remaining parts of the walls by bulldozer and built a house in the eastern part. This largely destroyed the historical monument. Since the place is located to the south of the village, it will not be affected by the reservoir.
13. Dakhana fortress, 16th to 17th century AD. It is located on the eastern side of the village and covers a square of 55 by 34 m. It was surrounded by protecting walls, but it was completely destroyed when the site was transformed into a field. Nothing is left of it.
14. Buni Sufiyon fortress, centuries 7 - 8, size 38 by 26 m. It will not be submerged and does not need to be investigated.

As can see from this list, a number of sites of historical interest were originally located within in Rogun reservoir area, but during the past years these sites were destroyed by changes in land use, and they cannot be studied any longer.

15.3 Historical Importance

The few findings of stone age sites confirms that the project area was inhabited already some 10'000 to 15'000 years before our area. Avesta (the holy book of Zoroastrianism), dating to 2'000 years BC, mentions a region called "Rankha" which, according to analyses of the writings and toponymy, is thought to correspond to the area where today Rogun is located. Graves from different periods have found in the project area, some form the Muslim period, others however considerably older. During several centuries the area had then a certain strategic importance, which is emphasised by the numerous fortresses which were built along the part of the silk road which led through the Vakhsh valley.

These few facts highlight the long time period during which the area has been inhabited. However, as the field work has shown, most of these historical sites have been destroyed, some of them rather recently, by human activities.

15.4 Conclusions

The following conclusions have been reached during the field reconnaissance carried out:

15.4.1 Chance find procedure

The investigation so far, including analysis of previous work carried out in the area of the project, did not give any indication that any sites or objects of archaeological or historical importance would have to be expected at and around the dam site. Furthermore, it has to be considered that major construction activities have started over

20 years ago, and that most of the construction site has been interfered with in a quite considerable way already. For these two reasons, it is not recommended to develop a chance find procedure for the site.

15.4.2 Exploration of sites within the reservoir area

Concerning the effects of the project on archaeological and historical sites, the following can be said:

- Out of the about 20 sites of historical interest in the project area, 12 were destroyed completely by different activities.
- Within the reservoir itself, there is no site of archaeological or historical interest which might require salvage action.
- However, Navodonak with the three fortresses of Dukhtarak, Pisarak and Boturkhon will probably be affected by the project. Therefore, it is recommended to carry out an archaeological investigation of this site. The funds required for such an investigation are estimated at TJS 300'000.00 (approximately USD 65'000.00). This cost, after checking of the exact location of the site and possibly making a more detailed estimate of the efforts required, will be included in the ESMP of the ESIA.

15.4.3 Local Culture

There is one additional point of historical and cultural interest, namely, the local culture of the present day population. Discussions with teachers and elders in Chorsada have shown that they conserve the history of their villages. Since this tradition and this knowledge is likely to disappear with the villages once the reservoir will be filled, it is important that this oral tradition should be recorded before this happens.

This work should be carried out by the Institute of History, Archaeology and Ethnography, Academy of Sciences of the Republic of Tajikistan.

16 CONSTRUCTION SITE MANAGEMENT

16.1 Material and Methods

For this task, the Consultant received different types of maps to get an overview over the existing situation and the coming works for the Stage 1 and 2 Project. In a one-week stay in Rogun, the whole area was visited. The travelled routes were tracked by GPS and points of interest were marked. An experienced engineer of Rogun HPP gave explanations and guidance.

During site visits, some elements of the existing Environment, Health and Safety (EHS) policy could be observed. To get additional information, two meetings with three responsible senior engineers were held.

16.2 Prevailing situation

During the site visit, the following main components were observed and tracked or marked by GPS:

- Village of Rogun
- Access road from road M41 to the site
- Constructing installations
- Dam site
- Gravel pits and storages
- Quarries and storages
- Roads and bridges
- Future sewage water treatment plant

In Annex 20.16 a number of photographs give a picture of the actual situation in Rogun construction site.

16.2.1 Work place risks

The following elements we considered as relevant for the aspect of work place risks:

- Health and Safety policy, containing prevention, reporting/procedures, responsibilities, training, measures, instructions, emergency equipment, rescue services etc.
- Tunnels and caverns (e.g. lighting, sign posting, personal safety equipment, communication inside the tunnels)
- Structural stability of all existing and future underground facilities
- The gorge with its steep rocks (rock fall risks), the surrounding of the two diversion tunnels, the fast flowing river, roads in steep slopes, abutments, bridges, injection works, preparations for dam stage 1, etc.
- Electric stations, transformers, wiring (partly in provisional style)
- Gas stations and storage of fuel/lubricants

- Exhausts in underground facilities
- Cement handling, concrete fabrication, rinsing of equipments
- Traffic in the whole construction site, especially in tunnels

The existing system to guarantee the envisaged level of safety can be described as follows, taking into account all observations made during site visits and all documents received from BT:

- A written policy does not exist, several documents (organisation chart responsibilities, safety instructions; Annex 16.1) were handed out.
- Several departments are responsible for safety and health issues (rock fall, fire prevention, health checks, hazardous goods).
- As the report on a accident (Annex 16.1) shows, a number of companies is involved in the ongoing construction activities.
- Accidents are being analysed and discussed in meetings where all heads of a department and responsible persons from the involved companies participate, in order to learn from the accident and to prevent further accidents.
- On a 24 h basis, a doctor is present on the construction site. A nurse and an ambulance support the doctors. In case of an accident, the doctor can treat a victim in 7 well equipped rescue stations (underground, only left river bank). A bigger rescue station is being built in the vicinity of the future powerhouse.
- The doctor in charge did arrive ca. 15 minutes after our demand to show us a rescue station. He was coming from doing a health check.
- Personal safety is partly delegated to the workers. The workers do not get personal protection equipment from their employers. The workers are mostly wearing helmets, but almost no reflectors.
- In tunnels and caverns the lighting is partly poor. Obstacles like machines, dumpers without light or reflectors or repair works on ceilings and pavement can hardly be seen.
- The speed in the tunnel is officially limited to 5 km/h. Thanks to this limit and also due to the poor condition of the pavements, the traffic is generally slow, which decreases the probability of accidents.
- On technical drawings, originating from the 80th, indications about safety are given. To the consultant it isn’t clear, who is working with these drawings on the construction site.

To complete the existing instruments concerning EHS, an Environment, Health and Safety Audit will be conducted.

16.2.2 Waste management

The following elements were defined related to waste management:

- Gas stations and storage (Gasoline and lubricants)
- Cement handling: production of concrete (for constructions, shotcrete and injections), rinsing of equipments, treatment of waste and wastewater

- Landfills and disposal sites, dumps, concrete slabs etc.
- Scrap metal, broken tubes, abandoned machines etc.
- Sewage water treatment plants (one in construction, one planned)
- Workshops (e.g. for trucks and shovels, iron parts for the power station)
- Electric stations, transformers
- Factories (e.g. prefab concrete)
- Metal smelter

Because of the long ago started constructing activities, it is not easy to understand exactly what happened on what place, which makes it difficult to define all hot spots.

16.2.3 Erosion protection

In Rogun, erosion is caused by rivers/creeks and by human activity. The human activity can be subdivided into farming practices on one hand and construction activities for the Rogun HPP on the other hand.

As relevant for erosion protection the following elements were defined:

a. Natural erosion by rivers and creeks

- Most of the riverbeds are steep, thus have a great capability to transport gravel and stones. Because of that, they are deepening with every important flood. The adjacent slopes get instable and landslides/erosion occur.
- Vakhsh River has formed a high vertical wall in sediments on the left riverbank. These sediments originate from creeks on the left side and are built up since the last ice age. The wall measures up to 100 meters and forms a risk because of its dimensions, should it collapse.

b. Farming practices

- Due to the growth of the population in the last century, the surroundings of Rogun are in general overgrazed.
- This leads to degradation of the soil and loss of fertility (Governmental Working group of the Republic of Tajikistan, 2003).
- More or less the whole region, with the exception of the rocky parts and the riverbeds, could be covered with a layer of shrubs and trees. Due to pasturing, logging and collection of firewood, the forests and bushes are reduced to minimal surfaces.
- Overgrazing and the cutting of trees leads to degradation of the soil, loss of fertility and increasing erosion or even landslides. Fertile topsoil and valuable agricultural land get lost, the pressure on the remaining land increases.

c. Construction activities

- Road construction
- Bridges
- Landfills and disposal sites for excavation material

- Quarries and open pits
- Discharge of (used) water into steep slopes or creeks

Annex 20.16 shows a number of photographs with typical situations of erosion.

16.3 Impacts

During the construction phase the existing problems with regard to EHS policy and waste management will increase. When Stage 1 is reached and the lake will be filled, an important amount of the cleaning work has to be finished in order to protect the water quality (e.g. soluble substances). For building the Stage 2 dam, the pressure on the remaining construction site facilities, dump sites etc. will increase significantly. While filling the final stage reservoir, all necessary cleaning work has to be done and measures to prevent or control erosion should show first results.

16.3.1 Impact of construction

Work place risks:

The actually observed and above described risks will intensify. An unknown number of additional workers will live for many years on the site, many of them with less experience and no knowledge of underground facilities. Workers with a diverse professional background and subcontractors with a short-term task will frequent the site. Heavy equipment, large machines and a great number of dumpers will travel on existing and new roads; traffic increases. Most of the work will take place in the dangerous gorge. The amount of handled dangerous and hazardous goods will increase significantly. The workers will be housed in more narrow compounds compared to now, what makes it necessary to keep an eye on the hygienic circumstances too.

Within the construction site a few villages still exist on their traditional spots. Therefore, the inhabitants and their livestock interfere with the building activities, which leads to dangerous situations (e.g. children on the way to school).

The existing EHS policy will probably not fulfil the required conditions. A comprehensive EHS policy should be implemented before construction works start.

Waste management:

As mentioned above, many waste producing activities will intensify significantly. These wastes can occur as solid waste, as fluid and as gas. In addition to dangerous goods that form a risk for the health of human beings, the amount of wastes that harm water, soil and air as well as flora and fauna will become greater.

The correct handling of the following dangerous / hazardous goods and wastes has to be guaranteed, mitigation measures will be proposed:

- Explosives
- Lubricants and fuel
- All products containing cement. Concrete, chemical substances / additives etc.
- Sewage water coming from households and construction site (e.g. parking lots / machinery pads, workshops, gasoline stations)
- Exhausts from all machines with combustion engines

- Exhaust, waste water and solid waste from the metal smelter

An Environmental policy does not exist, and in the treatment of waste some great lacks are noticed. A comprehensive environmental policy should be implemented before construction works start.

Erosion protection:

How the natural erosion, caused by the river and creeks will be influenced, depends among other issues on as yet unknown details of the project. It is important, that no riverbed is deepened and no bigger rocks and blocks are taken from here, because this would accelerate the erosion.

The sill dam that is actually being built in creek Obi Shur (Оби Шур; d/s, left bank) will in short time start to lift the riverbed. If this process is not stopped by excavating the sediment, the erosion in this valley will decrease.

Like mentioned before, the construction works will need more surfaces in the surrounding of Rogun. This will slightly increase the pressure of grazing.

The intensified construction activities for Stage 1 and 2 are as example:

- Road constructions, especially under steep conditions
- Bridges / abutments
- Quarries and open pits
- Landfills and disposal sites for excavation material
- Discharge of (used) water into steep slopes or creeks

Erosion protection has to be taken into account for the planning of details. First measures should be carried out, to obtain first results on the proposed mitigation measures (e.g. seeding/planting, fencing off against grazing etc.).

16.3.2 Impact of Stage 1

Work place risks:

The filling of the Stage 1 reservoir will have no important effect on the safety situation. Still, the EHS policy has to be implemented consequently.

Waste management:

The filling of the Stage 1 reservoir will have no important effect on the waste management. The waste management plan has to be implemented consequently.

Erosion protection:

At the mouth of the Vakhsh River and all the tributaries to the future reservoir, the riverbeds will lift themselves by sedimentation. Related to the discharge pattern of the lake and the size of the drawdown, this process goes faster or slower; fast and regular drawdown will reduce the forming of deltas. The process of delta forming can reduce natural erosion in a small area.

The TEAS-Team will answer the question, how the left bank wall will react, when it is submerged. The risk that is represented in this high vertical structure is potentially high.

The Stage 1 reservoir will inundate pastures, gardens, orchards, shrubs and perhaps even arable land (is to be verified). Parts of the construction site (e.g. concrete production, workshops, storage, housing for workers) have to be moved up, whether this is above the elevation of Stage 1 or above Stage 2. If, as a result from the waste management plan, some landfills have to be placed outside of the lake (poisonous and soluble substances), these landfills should be placed on even land or on gentle hill slopes, because:

- Disposal of clean excavating material should not take place in steep conditions or in valleys / gorges; new erosion problems would arise.
- Disposal of waste should only take place under controlled and stable circumstances. Steep conditions or valleys / gorges are to be excluded for landfills.

Landfills and disposal sites will probably occupy areas, which could be used as farmland. A sensible new topography and a cover of topsoil should make the preparation of new farmland possible.

Depending on the Resettlement Action Plan, the loss of farmland could result in a higher pressure of the remaining farmland. Measures for erosion control should go on, the obtained experiences with the first realized examples should be taken into account for the further planning. The proposed mitigation measured should be adapted to the lessons learned.

16.3.3 Impact of Stage 2

Work place risks:

When Stage 2 is reached, the final site preparation and cleanup above water level and beneath the dam have to be carried out. The reservoir itself has no important effect on the work safety situation. Although most of the workers will be gone and the main facilities are broken down, the implementation of the EHS policy has to go on.

For the site preparation new workmen or even local farmers will be needed to do the necessary seeding and planting, later on the maintenance of these surfaces (fencing, mowing etc.). These workers have to understand the aims of the EHS policy also.

Waste management:

The lake and the operation of the powerhouse will have no important effect on the waste management.

Erosion protection:

a. Natural erosion by rivers and creeks

Under Stage 1 the effect of sedimentation/siltation of the Vakhsh River and all contribution creeks was described. This same effect will slightly decrease the natural erosion in Stage 2 also.

b. Farming practices

The Stage 2 reservoir (of 170 km^2) will submerge pastures, gardens, orchards, shrubs, forests and arable land. Some irrigation systems will be submerged. The resulting loss of farmland as well as the substitute farmland in other regions of Tajikistan, have to be determined in the frame of the resettlement studies. It has to be underlined, that the intensive and uncontrolled livestock grazing is one of the main reasons for the erosion problems. For that reason, filling of Stage 2 reservoir should not result in an increasing pressure on the remaining farmland.

Region of Rogun village: One important aim of the site preparation has to be to regain as much farmland as possible. Therefore all landfills and disposal sites that remain outside of the lake have to be planned in a sound way (steepness of slopes, top soil, irrigation etc.).

The consultant recommends strongly, that for the whole watershed of Vakhsh River, a Pasture Management Plan (PMP) should be prepared and the implementation has to start during the construction phase, in coordination with resettlement. The perimeter for the PMP covers the watersheds of all tributaries on the left and right riverbank, adjacent to the future reservoir. The implementation would be a long and ongoing process that has to be developed and adapted to the experiences made. Such a management, if properly implemented, could considerably decrease siltation of the reservoir.

c. Construction activities

Once all the site preparation is done, the impacts of construction activities will end.

16.4 Measures

To reduce the risks on the Health and Safety side (i), to reduce (ii) and to compensate (iii) the impacts on the environment side, a comprehensive Environment, Health and Safety Policy has to be developed. This Plan will consist of a number of specific plans with special aims or a determined range.

Each of these plans will point out:

- Who is responsible on the management side,
- Describe the project,
- The problems and the measures,
- The reporting and controlling instruments,
- Training requirements and a
- Cost estimate.

An important part of the Waste and the Land Management Plan will be maps in order to have a practical tool to avoid, minimise and compensate negative effects.

After the scheduled “Environment, Health and Safety Audit” (end of June / beginning of July), the following two lists (Health and Safety, Waste Management) will be updated and worked out in detail. The lists show the elements where, with the present knowledge, mitigation is expected to be necessary.

Table 16-1: Health and Safety: elements where mitigation is required

Element	**Aim**
Health and Safety Plan	Comprehensive Plan for all stages, works, workers, situations
Lighting in tunnels and underground structures	Increase safety
Personal protection equipment	Usage 100 %, anywhere, anytime, everyone
Electrical installations	Analyse accident statistics Improve safety
Gasoline and lubricants	Close and Cleanup existing Stations Minimize dangers for Man and Environment
Structural stability	Analyse accident statistics Improve safety
Air quality in underground facilities	Decrease exhaust at the source Improve ventilation
Metal smelter	Minimize dangers for Man and Environment (exhaust)
Cement (incl. additives)	Improve handling Minimize dangers for Man and Environment Stop exhaust from silos
Hygiene	Improve sanitary situation (lack of toilets on site)

Table 16-2: Waste management: elements where mitigation is required

Element	**Aim**
Cement (incl. additives) and concrete	Minimize dangers for the Environment, e.g.: Recycling used water Treatment Wastewater (collecting, neutralizing, sedimentation) Correct disposal of slurry
Landfills (waste)	Acquire knowledge about contents Organize correct treatment
Disposal sites ("clean" excavation material)	Acquire knowledge about contents Improve stability (avoid landslides)
Workshops and factories	Cleanup old/existing sites Organize correct treatment waste Prescribe layout of new to build workshops
Metal smelter	Demolish the smelter as soon as possible Cleanup old/existing site Organize correct treatment of waste
Waste	Improve the collecting system Separation of waste Improve disposal pathways
Scrap metal	Collect all scrap metal Correct recycling
Sewage water (from households)	Treatment of wastewater

The following list shows the elements where, with the present knowledge, mitigation is expected to be necessary and how the aims could be reached.

Table 16-3: Erosion protection: elements where mitigation is required

Element	**Aim**	**Possible Measures**
Natural erosion (river and creeks)	Decrease sedimentation Secure farmland	Erection of small dams, walls or piles of blocks in creeks, in order to lift the riverbed (only on places, where access is already given, e.g. close to fords and bridges, only on elevations above future lake) No more gathering of stones and pebbles in riverbeds
Farming practises: Grazing and Logging	Manage grazing in a sustainable way Mitigate loss of farmland	Implement PMP in the surroundings of Rogun construction site Seeding slopes, landfills etc. Gather seed (grass, herbs, shrubs, trees) and cuttlings (shrubs, trees) in the close neighbourhood Protect seeded and planted surfaces against grazing for a few years Planting fruit trees, organize maintenance Reforestation
Road construction, bridges	Minimize loss of farmland Avoid man made erosion problems	Taking the topography more into account when planning and constructing new roads: Build the roads as narrow as possible, especially in steep conditions Allow more curves No deep cuttings in the topography Realise slopes in a stable angle Realize retaining facilities like walls and gabions along existing and new roads
Landfills and disposal sites	Mitigate loss of farmland	Form topography which allows farming Finish with a layer of topsoil (minimally 1m) Seeding slopes and cover Gather seed (grass, herbs, shrubs, trees) and cuttlings (shrubs, trees) in the close neighbourhood Protect seeded and planted surfaces against grazing for a few years Planting fruit trees, organize maintenance Reforestation
Quarries and gravel pits, storages (only outside future lake)	Mitigate loss of farmland	See above
Discharge of water into steep slopes	Realize proper discharge of surface runoff water, coming from roads, construction sites, housing etc.	Collect and lead water to existing creeks/pipes Construct artificial creeks that can withstand erosion (riverbed out of stone blocks)

16.5 Conclusions and Recommendations / Next Steps

16.5.1 Prevailing Situation

To describe the prevailing situation of Rogun construction site, an overview will be drawn for the ESIA report. To have a closer look on the dam and construction site itself, a map with bigger scale will be drawn also.

For these final drawings, the consultant will receive maps in electronic format (.dwg). Photos from the visit, information from GPS and maps.google.com will be used to do the drawing work. New aerial photographs with a good solution would be helpful.

16.5.2 Work Place Risks

As mentioned before, the consultant will conduct a strict EHS audit. After this, a map will be drawn to light out the hot spots of work place safety. This map will help to determine the importance and scale of different problems, which are to be solved in Stage 1 and stage 2.

Concerning the structural stability of underground facilities, the TEAS-Team will formulate recommendations to increase safety.

16.5.3 Waste Management

To get an overview of the site and to get an idea of the scope of problems to be dealt with, a map will be drawn. Each category of waste will be described with a view to danger for the environment, possible amount of waste and possible treatment.

Based on this screening report the consultant will propose a methodology for an inventory of all hazardous wastes, including e.g. historical research of dumps and disposal sites, excavations, research in laboratories etc.. Focus will be on substances that are dangerous for the environment or the future reservoir. Investigation mainly should be done for:

- All kinds of used oils (e.g. in transformers), fuels and lubricants
- Chemical additives to concrete, waste from production of concrete (slurry in ponds near Vakhsh River)
- Covered landfills and visible waste like used tires, barrels.

The vulnerability of the river, the creeks and the groundwater will be discussed (e.g. in relevance to high pH / strong alkalinity of waste water from concrete production). The amounts of waste that should be treated will be estimated by measurement of surfaces and taking into account the long duration of construction work. Possible pathways of recycling and treatment will be discussed.

16.5.4 Erosion Protection

To get an overview, a map will be drawn to show the scope of the three mentioned categories of erosion. This map will help to get an idea of the dimensions of the problems as well as of possible solutions.

A land management plan will be prepared, which indicates the areas where measures are required. These measures will be specified and described in detail (including costs for implementation). To improve erosion control in the frame of this plan, some principal rules about the layout of instable slopes will be proposed. In order to get as soon as possible some experience with these rules, pilot projects should be carried out.

To obtain the desired layer of grass and herbs, the gathering of the right seeds has to be coordinated with or guided by the botanist.

17 TRANSBOUDARY ISSUES

17.1 The Situation

As has been discussed in Section 4.2.3, Rogun undoubtedly has to be considered as being a project on an international waterway (transboundary or shared river). The effects of Rogun on water availability for use in the downstream area therefore have to be considered very carefully.

Downstream riparian countries in this sense are Uzbekistan and Turkmenistan. They use the water of the Amu Darya, mainly for irrigation, but also as drinking water source and for sanitary purposes. Turkmenistan, for its water supply, depends to a very great extent on the Karakum channel, which leads from the Amu Darya near Kerki to the Caspian Sea; construction started in 1954. It abstracts 12-13 km^3 of water annually from Amu Darya (about 400 m^3/s) which, according to the agreements, corresponds to a share of about 35 from the flow of Amu Darya at Kerki. Since the channel is not covered and not lined, about 50% of this water is lost to evaporation and seepage. The remaining water is then largely used by Uzbekistan.

One of the major ecological problems - and one for which there is as yet no solution - is the shrinking of the Aral Sea (see short description in Section 8.2.4). It is important to point out here again that the flow of the Amu Darya at the point where it leaves the mountainous area remained largely unchanged in the last 100 or so years (see Section 8.2.1). This means that current water use in Tajikistan, mainly for hydropower, did not have a noticeable effect on the Aral Sea. However, water abstraction further downstream led to a reduction in inflow to Aral Sea. It has to be seen clearly that none of the water flowing into the Karakum channel will reach the Aral Sea, since much of it is being consumed for irrigation and the remainder flows into the Caspian. Likewise, the water used for irrigation in Uzbekistan is consumed to a large extent, i.e. does not return to the river.

The third downstream riparian country, Afghanistan, so far makes very limited use of its water resources. However, even if this should change, e.g. by constructing hydropower plants or the establishment of irrigation schemes along the Amu Darya on its territory, Afghanistan presumably will not use water stemming from Tajikistan (with the possible exception of Tajik-Afghan border hydropower plants on the Pyanj river), but rather use water from tributaries to the Amu Darya. Without doubt this would have a direct effect on water availability in the downstream area; this, however, cannot be addressed here.

17.2 Position of Uzbekistan

On April 27, 2010, Mr. Dishod K. Akhatov, Ambasador of the Republic of Uzbekistan in Germany, handed over a number of documents to the Consultant, which describe the position of Uzbekistan on the problems of water availability and sharing of water resources in Central Asia. These documents are summarised hereunder.

Paper entitled **"Position of Uzbekistan for Regulating Water Problems in Central Asia"**

(Original in German)

This paper, in a general way. lines out the nature of water problems of the region.

Important points are reflected here.

The fate of the Aral Sea and the fact, that water deficit is negatively affecting agriculture and therefore exacerbates social problems are pointed out as main issues.

The position of Uzbekistan is summarised in the following points:

- The issue of use of water resources of the transboundary rivers in Central Asia have to be solved taking into account the interest of the populations of all the countries in the region, totalling over 50 million people.
- Any action on transboundary rivers must not have and negative effects on the resulting environmental and water balance of the region.
- The basis of international laws on water use and ecology has to be the cornerstone for developing and efficient system for common use of the resource of transboundary rivers in Central Asia.
- The right of all parties for developing projects for using the resource of transboundary rivers, including the construction of hydrotechnical plants, is not objected, under the condition of a thorough techno-economic and ecological analysis in the interest of the principles of transparency and a complete information of all stakeholders.
- Project implementation is being done in a constructive way and a readiness for compromise, whereby the interests of the other interested states must not be impaired, and under two very important conditions:
  - first - a reduction in water level for the downstream countries cannot be tolerated;
  - second - the ecological safety of the region must not be affected.

It is then stated that all questions related to guaranteeing the water-energy-balance in Central Asia have to be solved on the basis of mutual understanding, bilateral dialogue and consensus among the counties of the region, and that a violation of these principles could have unpredictable ecological, economic, social and political consequences in the region. It is also stated that the position of Uzbekistan is based on international laws, and does by no means imply any special rights for Uzbekistan. It is also emphasised that World Bank and Asian Development Bank take a similar position to this question, and that this position will serve as an example also for other organisations involved in hydropower projects in the region.

Paper entitled **“The Problems of the Aral Sea can be solved only in a common effort”**

(Original in German)

This paper presents a short overview of the problems of the shrinking Aral Sea, like desertification, negative effects on the population of the former seashore areas, salt and dust carried away and deposited on land in the entire region, reducing its fertility, lack and bad quality of water. It is mentioned that a number of projects are being implemented for mitigating the problems, like e.g. the plantation of salt tolerant plants on the former sea bed for reducing wind erosion. The cooperation with other countries, France and Germany among them, and international organisations like GEF, UNDP and WB is emphasised, as well as the necessity for all countries of the region to join international treaties for the protection and use of transboundary rivers.

Paper entitled **"Summit in Almaty: Questions of Ecological Safety Were Central Issues"**

(Original in German)

This is a short note on a meeting of the heads of state of the Central Asian countries (Uzbekistan, Kasachstan, Kyrgystan, Tajikistan and Turkmenistan) which took place in Almaty on April 28, 2009, and where problems of the Aral Sea and the water resource use were discussed.

Of relevance in the context of the ESIA for Rogun HPP are the following two paragraphs:

"It is known that states located in the upper reaches of the transboundary rivers intend to build new hydropower stations. Such activities can cause serious harm for countries located along the lower reaches of transboundary rivers, leading to an even much worsening environmental situation. Considering that Central Asia is located in a seismic active zone, there is also a problem of dam safety."

"Therefore, before the construction of hydrotechnical projects on transboundary rivers is started, it is required to consult all neighbouring countries, to organise an independent international expertise and to obtain the expertise on dam safety and an environmental assessment for the project."

It is also emphasised that the Central Asian states are capable and willing to solve these problems.

Speech of the President of the Republic of Uzbekistan, Islam Karimov, at the Plenary Meeting of the UNO Summit on Millennium Development Goals, Sept. 9, 2010

In this speech, the President of the Republic of Uzbekistan addressed a number of problems in the Central Asian Region, which are related to the UN's millennium goals.

Of relevance for the present study are the following paragraphs:

"It has to be considered that the Aral Sea region gets its water supply from two important rivers, the Amu Darya and the Syr Darya, and that any reduction of the flow of these rivers constitute a violation of the already fragile ecological balance in the entire area."

"Under these circumstances, all attempts of building the enormous hydropower plants with gigantic dams, conceived 30 to 40 years ago during the Soviet period, [have to be rejected], especially considering that the seismicity in the region of the planned constructions reaches magnitudes of 8 to 9; all this can cause irreparable damage to the environment and the most dangerous technological catastrophies."

"It would make more sense, as proposed by many international environmental organisations and by respected experts, to build less dangerous, but economically more efficient smaller hydropower plants with the same capacity on these rivers."

17.3 International Water Management

Up until 1992, the allocation of the Amu Darya waters among the four Central Asian republics (Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan) was based on the water development master plan for the Amu Darya basin. The allocation plan was approved by resolution 566 of the Science and Technological Council of the USSR Water Management Ministry in 1987. The resolution fixed the following allocation of surface waters (% of projected flow in the main stem of the Amu Darya): Kyrgyzstan, 0.6%; Tajikistan: 15.4%; Turkmenistan, 35.8%; Uzbekistan, 48.2%. The quota principle has survived till now, with Turkmenistan and Uzbekistan getting equal shares of the so-called adjusted run-off measured at the Kerki hydrographic section.

When the republics in the region gained their independence as new nations, it became necessary to set up a mechanism for regional cooperation in the organization of water resource management. On 12 October 1991, the Water Ministers of the new independent states jointly declared they would continue using the earlier existed Soviet principles of water allocation. An interstate agreement was signed on 18 February 1992 to reflect this commitment and also laid a foundation for the regional cooperation by establishing a technical Interstate Commission for Water Coordination (ICWC), responsible for determining and approving annual water allocations for each state and approving schedules for the operation of reservoirs.

On 26 March 1993, the five states of Central Asia signed a new agreement that affirmed the commitment of these states to cooperate in the management of the basin's water resources. The agreement established regional institutions charged with comprehensive water management, including Interstate Council on the Aral Sea Problems (ICAS, a high level body charged to recommend actions to the five governments in the name of the basin as a whole) and the International Fund for the Aral Sea (IFAS, a high level body charged with financing the activities of ICAS).

Following a Heads of State meeting in February 1997, ICAS and IFAS were merged into a newly structured IFAS – International Fund for Saving the Aral Sea. As a result, the political level of decision related to water and environmental sectors in the region belongs only to the Board of IFAS consisted of the deputy prime ministers of five states. This is the highest political level of decision-making before approval by the heads of state (if appropriate). The most important issues can be decided only at the meetings of the heads of states followed by their recommendations/approval for IFAS. IFAS Executive Committee was established as a permanent body that included two representatives from each state and implements the IFAS Board decisions through the IFAS National Branches.

In 1994, the Heads of States adopted the Aral Sea Basin Program that was designed to be administered by the new regional institutions. Establishment of the Program was aimed to prepare a general strategy for water distribution, rational water use, and protection of water resources in the Aral Sea Basin. Following the establishment of the Program, Heads of States have met at least once a year during the next 6 years to further develop, approve and express support to the Program. In 1999, Heads of States adopted Ashgabat Declaration where they stressed their support to joint actions to address shared environmental problems in the basin and promote better quality of life for people living in the Aral Sea Basin. At the summit of the Head of States in 2002 in Dushanbe, Main Directions of a program of specific measures aimed to improve socio-economic and ecological situation in the region for the period until 2010, were adopted.

During the past decade there has been progress in the development of the interstate regional cooperation in the Aral Sea Basin as multiple agreements and conventions were signed and institutions established. However, the legal basis for the interstate cooperation between the Central Asian states is still in the development process.

17.4 Open Issues

In order to achieve genuine interstate cooperation in the Aral Sea Basin, and subsequently in the Amu Darya river basin, there is still a number of developments to be done and issues to be addressed:

- **Afghanistan** accounts for 15 % of Amu Darya basin and contributes 8% of its flow, but has so far remained essentially excluded from the Amu Darya management structures. One of the challenges for fostering cooperation within the Amu Darya basin is the inclusion of Afghanistan, as the total area of irrigated land in Northern Afghanistan is approximately 1.2 million hectares of which 385,000 hectares is on and along rivers with permanent flow to the Amu Darya;
- **Water quality:** unlike the agreements regulating water quantities, there are no legally binding provisions on water quality in a cross border context (however, all Central Asian countries of the CIS have national regulations on water quality);
- **Amu Darya basin management costs:** there is no interstate agreement for the Amu Darya basin that addresses responsibilities and cost sharing of operations, maintenance, rehabilitation and modernization of the regulation infrastructure;

- **Information system:** there is no interstate agreement for an Amu Darya Basin common and reliable water monitoring system that would allow monitoring, managing and controlling river flows and water uses;
- **Environmental needs:** the existing regulations do not enforce the preservation of environmental flows in the Vakhsh and Amu Darya rivers, which creates a threat for the natural reserves located along the water courses, and results in chaotic release of water to the Aral Sea which is used like a buffer;
- **Water / energy interdependencies** that existed during the Soviet period in which water and energy were exchanged freely on a mutual interest basis are no more existing.

These issues will have to be addressed and solved among the states which share the Amu Darya Basin.

17.5 Assessment of Riparian Issues

Addressing any impacts Rogun might have on the downstream riparian countries is one of the main tasks of the ESIA. Here, it is described very shortly how this will be handled, and what the expected outcome will be.

17.5.1 Evaluation of Water Uses in the Riparian Countries

To some extent, water uses in the Amu Darya basin was addressed (see Section 8.2.5). In the following phases of the study, additional information will be added as required, and provided such information becomes available. This information will serve as a basis for assessing potential impacts on water availability, and thus on water users, in the downstream area. However, it is not planned to establish a simulation model of the entire water use chain in the Amu Darya basin.

17.5.2 Vakhsh Cascade Model

As outlined in Section 8.7.2, a hydraulic model of the Vakhsh cascade will be prepared and applied be TEAS. This will used the hydrological data available and the BVO conditions as agreed among the involved states for modelling the hydrological situation of Vakhsh river under different assumptions for Rogun HPP operation.

The model will be used in an iterative process, input conditions being modified, if required, to finally define a scenario - or an operational pattern - for Rogun which takes into account the requirement of the main stakeholders, i.e. mainly the production of electricity in Tajikistan and the availability of irrigation water in Turkmenistan and Uzbekistan.

17.5.3 Assessment of Effects

The results of the model will be checked in detail, and effects this situation would have on downstream riparian countries will be evaluated carefully. If the results of this analysis will show important negative effects, measures will be formulated (and their effect tested in the model) for minimising them (either eliminating them altogether or reducing them to an acceptable level).

The aim, as was said in Chapter 8. is to come up with an operation scheme for Rogun which will remain within the accepted water allocation pattern defined by Protocol No. 566, and which will not alter the seasonal flow distribution in Amu Darya at the point where the river leaves Tajikistan.

It is obvious that Rogun HPP, and the Tajik Government, do not have any influence on water allocation, distribution and use below this point.

17.5.4 Measures and Recommendations

Once the optimum scenario (or scenarios) defined, measures will be prepare and recommendations made aiming at making the best use of water resources in this area for all stakeholders.

18 CONCLUSIONS AND NEXT STEPS

18.1 Coordination with Other Studies

According to the TOR, the ESIA has to be coordinated with some other studies. A few comments on this are made here.

18.1.1 TEAS

The TEAS is being developed in parallel with the ESIA. The main points made in the TOR on coordination of ESIA with TEAS are the following:

- Para 28: “The Consultant will initiate this initial assessment at the start of the engineering studies and work parallel to the Techno-Economic Assessment Study (TEAS) Consultant. The screening report will be submitted during Phase 2 of the TEAS, taking into account the assessment of the existing situation at Rogun (as produced in Phase 1 of the TEAS) and providing input to the project definition of Phase 2.”
- Para 44: “ A detailed risk analysis will be conducted in close cooperation with the TEAS and should include geological and seismic hazards, especially a detailed analysis for induced seismicity, which in studies performed during Soviet period, have been found to be a potentially significant risk. If issues of relevance are identified, they shall be communicated to the TEAS Consultant to be included into the technical risk management plan. The context of landslides in the reservoir area and induced seismicity should also be explored under this topic.”
- Para 51: “...Analysis of Alternatives – Making use of the outputs from the TEAS and the SEA, systematically compare feasible alternatives ...” “...Instrumentation and Monitoring Plan: Drawing upon the work of the TEAS Consultants this consultancy will update and supplement be the plan ...“ “...Emergency Preparedness Plan,... This plan shall be prepared as envisaged in Annex A to BP 4.37 (Dam Safety) of the Operational Policies of the World Bank. Execution of part of these services in phases II and III assigned to the consultant for TEAS under another task and consultant has to perform these services, taking into account the data obtained from TEAS.”
- Annex 6, Para 2/3: “Paragraph 6.11 of the TEAS TORs also instructs the consultant to prepare an initial reservoir filling schedule as well as simulating reservoir operations for the next 50-60 years.”

Contact with the TEAS Consultant was established early in the study. However, the exchange of information needs to be improved.

18.1.2 Other WB Studies

The TOR make the following main statements on the SEA:

- Para 5: “a Strategic Environmental Assessment (SEA) will be conducted in a separate assignment to investigate power production scenarios and establish the relative economic, environmental and social performance of identified scenarios, tradeoffs and linkages to other energy sector projects both in country and region.”

- 4.2.1, para 21 ff: “In the initial stages of the environmental assessment process a strategic environmental assessment (SEA) will be prepared under a separate consultancies, which will include strategic environmental considerations for potential alternative power production scenarios. … Specifically the SEA will analyze, from the environmental and social points of view, Tajikistan’s energy policy, the current planning for energy sector, the role of the Vakhsh River Development Master Plan and currently developed transmission projects in the energy policy and long term planning, and the government’s schemes on energy sources other than hydropower (e.g. coal fired TPP, renewable energy) and energy conservation. The SEA will obtain the results of the load forecast scenarios, export demand data and the related least cost generation development alternatives produced by the Consultants and carefully analyze related economic, environmental, social implications of the existing and proposed generation alternatives and their interactions with other sectors such as transport, infrastructure or mining, as well as the Central Asia energy sector. Strategic issues relevant to the Vakhsh cascade will be carried over from the SEA to the ESIA.”
- Annex A: “The strategic environmental assessment (SEA) envisaged for the full size Rogun HEP is anticipated to start parallel to the Stage 1 assessment.”

The results which should be provided by the SEA are considered as important by the Consultant. This concerns the comparison of alternatives, but quite specifically also the assessment or power needs and energy policy of Tajikistan.

Until now we do not have any information indicating that such a study has been launched.

One additional item is the Dam Safety Study. According to the TOR

- Para 72: “Parallel to the ESIA a Dam Safety Report (DSR) will be elaborated by the Panel of Experts (PoE). The Consultant will be aware of its progress and the activities of the PoE and draw upon / integrate relevant findings.”

Dam safety and risk assessment will be topics for the ESIA. As soon as the results of this study will be available to the Consultant, they will be integrated.

18.2 Areas of Main Concern for the ESIA

The preceding Chapters have shown clearly that not all of the topics covered by the ESIA are of the same importance. Shortly, the following main conclusions have been reached:

- **Climate:** climatic conditions as such are not of concern for the study; the reservoir will be too small for actually influencing the climate even on a local scale. However, the issue of climate change might be of more importance. It remains to be decided (by BT and WB) to what extent this issue should be investigated.
- **Hydrology:** the importance of this subject is quite obvious, since the Project has the potential to influence the conditions in the downstream area in a considerable way. Given the needs for water downstream of Nurek dam (for irrigation,

drinking water, the persistence of the special ecosystem in the Tigrovaya Balka Nature Reserve, and including the operation of Nurek HPP itself), but especially given the implications for the riparian countries, it is obvious that this aspect needs to be analysed carefully. This will also require an interaction with the TEAS Consultant (e.g. modelling of Rogun filling phase and operation).

- **Geology:** important aspect mainly with relation to slope stability, erosion risk, reservoir sedimentation, and dam safety. Exchange with the TEAS Consultant needs to be intensified.
- **Biodiversity:** the analyses carried out so far have shown, that the project area does not contain any biota of exceptional value. This is largely related to the quite intensive human use of the area. The vegetation in general is of a type which is widespread in Tajikistan (and beyond), and shows signs of partially severe degradation, not in the least due to overgrazing and the lack of proper pasture management. This has effects on the fauna, which can also be considered as affected by human interference. No species (neither of plants or animals) will be in danger of becoming seriously reduced or even extinct due to the Project. The fish fauna is impoverished; this is certainly in part due to Nurek dam, and the fact that a number of exotic species were introduced into the area in an attempt to develop fisheries in the reservoir might have contributed to this. The only potentially significant impact which Rogun HPP might have is the one on Tigrovaya Balka, by further influencing the hydrological conditions in this floodplain area which depends entirely on river dynamics; this emphasises the importance of hydrological considerations in this project.
- **Resettlement:** this is undoubtedly, along with hydrology, the second of the two most important issues to be dealt with in the framework of this Project. An important number of people need to b relocated, and as the analysis so far has shown the situation is made more complex and more difficult to understand by the fact that resettlement has started almost 30 years ago, was then interrupted by the political and social consequences of the breakdown of the Soviet Union and the independence of Tajikistan, and is presently under way.
- **Archaeology:** while the analysis has shown that the project area has been inhabited since the stone age and later on had a certain importance due to its location on the silk road, it has also revealed the fact that most historical sites and artefacts in the area have been destroyed by human activities. Two aspects remain which should be investigated as part of the compensation measures, namely (i) one site of still at least partly intact fortresses which might be affected by the reservoir, and (ii) the local ethnography, which otherwise will be lost due to the relocation of the population.
- **Environment, Health and Safety:** this is a subject of importance for the construction period (which, at least to some extent, is going on right now). A number of issues have been identified during the preliminary investigation, and a framework for a comprehensive EHS management on site will be developed in the ESIA.
- **Site restoration:** this is an aspect of importance for every large construction site. In the case of Rogun HPP, however, it is strongly related to the geological conditions, and mainly to the risks of erosion and landslides. Measures will be proposed for reducing these risks.