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# A REVIEW OF THE HYDROLOGIC AND GEOMORPHIC IMPACTS OF THE PROPOSED ILISU DAM

Prepared for

The Corner House

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# 1. INTRODUCTION

The companies of the Ilisu consortium are currently seeking export credit support from a number of European Union countries and the USA in order to participate in the construction of the proposed Ilisu dam in southeastern Turkey. Before granting such credits, the governments concerned require a full consideration of the environmental consequences of constructing and operating the dam. In response to this requirement, the engineering contractors[1] selected by the Turkish Ministry of Energy and Natural Resources have contracted with the Ilisu Engineers Group (IEG)[2] to prepare an environmental impact assessment report (EIAR) in accordance with Export–Import Bank guidelines. These guidelines (EIAR Appendix 24) list potential impact categories that should be addressed but do not necessarily require the kind of systematic environmental assessment that has now become standard practice by most international financial institutions and many national governments. In 1997, the Government of Turkey adopted Environmental Impact Assessment Regulations but specifically excluded projects, like the Ilisu dam, whose final design had been previously approved [p1-6]

The purpose of the IEG's EIAR is described as 'to allow full consideration of the environmental impact of the project by the Turkish authorities as well as by the relevant international financing institutions' [p1-6]. The IEG acknowledges that because the design and operational plan of the Ilisu Dam was developed before 1982, without integrating environmental considerations, the EIAR does not comply with contemporary international standards [p1-7]

Worldwide, large dam building technology is relatively new and in the last 20 years has produced a substantial amount of new research and practical experience concerning the impact of large dams on major river systems. In many instances unanticipated environmental impacts have adversely affected or even frustrated the original economic development goals of the project (WCD 2000). Because of the importance of the possible large scale hydrologic, geomorphic and water quality impacts of the dam on the Tigris River system, PWA Ltd. has been contracted by The Corner House to provide an overview of these potential physical effects and an assessment of whether the EIAR published by the IEG adequately describes these impacts. PWA was requested to summarize its findings in this report to be completed in time to be submitted to relevant governments prior to their decision-making in the fall of 2001.

Unfortunately, important technical source documents cited by IEG-specifically the design and operational plans cited in the EIAR, were not made available to us because the consultants were not certain who owned them (Appendix B). In the short time available to prepare this review we were unsuccessful in resolving this question. This has meant that we have had to rely on the EIAR itself and on prior published articles as the primary source of our data. Except as noted for the purpose of this

[1] The engineering contractors are Balfour Beatty (UK), Sulzer Hydro (Switzerland), and Impregilo (Italy)

[2] The IEG is composed of Hydro Concepts Engineering (Switzerland), Hydro-Quebec International (Canada), Colenco (Switzerland), and Dolsar (Turkey).

review, we have assumed hydrologic and engineering data presented to be accurate but have not carried out independent checks.

## 2. CONCLUSIONS

1. The Ilisu Dam is a major component of an integrated water development scheme planned in the 1970's for the upper Tigris watershed. The goal of this scheme is to provide economic development within the region through the generation of electricity and large scale irrigated agriculture. While the EIAR states that the Dam is "a single purpose hydroelectric facility" [p2-13] it will also 'increase the water available for irrigation' [p4-39] by storing seasonal runoff that will be released and then diverted from the river downstream at the planned Cizre Dam. Diversions from Cizre are planned to irrigate approximately 121,000 ha.

2. The construction and operation of the Ilisu Dam by itself, will significantly affect the hydrology of the Tigris River. It will alter the seasonal flow pattern by capturing all except large flood flows in the spring and releasing them in the fall and it will create large daily flow fluctuations whose influence would be felt more than 65 km downstream at the Syrian border.

3. The operation of the Ilisu Dam in combination with diversions from the future downstream Cizre project would probably significantly reduce summer flows in Syria and Iraq below historic levels. It is likely that a significant portion of the recommended minimum flow release from Ilisu of 60 $m^3/s$ during dry years would be diverted. It is even possible that with full implementation of the Ilisu/Cizre projects, during drought periods, all the summer flow could be diverted before it crossed the border.

4. Future depletions of the Tigris river flows for planned irrigated agriculture within Turkey would further reduce these flows.

5. Filling of the Ilisu reservoir could create low flow conditions downstream in Syria and Iraq more severe than those experienced in an extreme drought for two successive years.

6. The Ilisu reservoir would eliminate small to moderate flood peaks downstream but would not significantly reduce extreme large flood peaks.

7. There are large uncertainties in estimates of reservoir sedimentation rates. It is possible that with future deteriorating watershed conditions active reservoir storage losses would be in the range of 0.1 to 1 percent per year. This could adversely affect power generation within a few decades.

8. Deposition of coarse sediments in the mouths of rivers discharging to the reservoir will cause increased flood levels, waterlogging, and increased channel migration along tributary rivers upstream.

9. Large seasonal reservoir level fluctuations would typically expose approximately 100 $km^2$ of reservoir bed, as summer diversions increase upstream this drawdown area could increase to about 190 $km^2$.

10. Capturing of coarse sediment in the reservoir will tend to induce scouring of the river channel downstream, lowering the river level and possibly lowering the adjacent water table as well.

11. High levels of nutrients from sewage and agricultural runoff will cause eutrophication and anoxic conditions in the reservoir. Planned sewage treatment plants will not significantly reduce these levels.

12. Anoxic conditions will probably mobilize heavy metals from reservoir sediments.

13. Discharges from the reservoir will be anoxic and likely to contain high levels of nutrients, organic matter and hydrogen sulphide ($H_2S$).

14. Downstream water supply in Syria and Iraq could be significantly affected by both reduction in summer flows and deterioration in water quality.

15. There could be a significant increase in flood hazards downstream. The elimination of smaller floods will encourage the development of floodplain and river channel land; however these areas will still be subject to extreme flood events.

16. The consequences of failure of the dam due to accident or act of war would be catastrophic affecting millions of people living downstream.

17. Summer exposure of large areas of reservoir bed, as well as aggrading river channels upstream, will provide a major habitat for disease vectors such as malaria etc.

18. Pollution and eutrophication of the reservoir could create public health hazards for people drinking water or eating fish caught in the reservoir.

19. Anoxic conditions in the reservoir will likely generate significantly higher levels of greenhouse gas methane emissions than occur from the existing landscape.

20. We do not find key conclusions presented in the EIAR to be justified, in some instances because they are unsubstantiated, in others the information on which they are based is contradictory, incomplete, of unknown accuracy, or inappropriate level of analysis.

21. We find the methodology or logic of the EIAR to be seriously flawed because the Project definition is unclear, cumulative impacts were not addressed, transborder impacts were ignored, and impacts were not analyzed over the lifecycle of the project.

22. It appears that key decisions on the Ilisu dam and operational design were made 20 years ago without integrating environmental planning, as is now the established practice. Instead the EIAR attempts to analyze the consequences of decisions already taken and suggest mitigation actions that are not part of the project, which might be taken to reduce adverse impacts.

23. On many important issues the EIAR does not present an impartial assessment but instead seeks to minimize the significance of adverse impacts or argue that they will be mitigated.

24. There is no substantiation provided in the EIAR for the selection of the minimum monthly flow release of 60 $m^3/s$. Nor is evidence presented that downstream riparian countries were consulted to establish such a minimum release rule.

25. The accuracy of information on which the EIAR was based cannot be independently evaluated because it was not made available for public review. No peer review of this document by qualified environmental assessment specialists was carried out.

26. It does not appear that the proponents of the Ilisu dam have carried out the kind of technical studies reasonably expected to evaluate environmental impacts for a major project of this type. For example: reservoir water quality modeling, operational scenarios for future watershed conditions, river and reservoir sedimentation modeling, dam break analysis, and flow fluctuation attenuation modeling.

## 3. SETTING

The Tigris River is the second largest river in southwest Asia (1,840 km). It is an international river shared by Turkey, Iraq, and Iran, with Syria as a minor riparian. Parallel to its twin sister the Euphrates, it flows through one of the most arid regions of the world, and is relied on by an increasing number of people for agriculture, urbanization and industrialization. Within the last two decades both Turkey and Iraq have started to implement ambitious water development schemes that are transforming the river, and the lives of people who depend on it.

Downstream of Turkey, Iraq is extremely dependent on these two major rivers as its only sources of water. Iraq completed the large multi-purpose Mosul Dam (or Saddam Dam) with a reservoir capacity of 10 billion $m^3$ in the late 80's, and is currently constructing another big dam on the Tigris with a reservoir capacity of 12 billion m3. The Mosul Dam, combined with massive drainage works constructed after the Gulf war, has resulted in the transformation of the lower Tigris River and the destruction of the unique Mesopotamian marshland ecosystem, displacing the indigenous Marsh Arabs (EOS 2001).

The Turkish government is seeking to exploit the upper part of the Tigris River as part of its Southeastern Anatolia Project (GAP). The GAP is intended to be an integrated regional development plan covering a wide array of sectors such as irrigation, hydraulic energy production, agriculture, urban and rural infrastructure, forestry, education and health (http://www.gap.gov.tr). Its closest conceptual analogues are the American Tennessee Valley Authority planned in the 1930's or the Mekong Valley Scheme, planned in the 1960's (Kolars and Mitchell 1991). The GAP project area covers about 10 percent of Turkey, and according to the 1997 census approximately 9.5 percent of Turkey's population lives within the area being developed by the GAP. The water resources program of the GAP envisages the construction of 22 dams and 19 power plants and irrigation schemes on an area extending over 1.7 million hectares. The total cost of the GAP project is 32 billion US$, with energy and agricultural projects having a share of 32 and 30 percent, respectively (http://www.gap.gov.tr).

The Ilisu Dam and Hydroelectric Power Plant is the centerpiece of the GAP development plan for the Tigris River. It is a 135 m high rockfill dam located 65 km upstream of the Syrian border and will create a reservoir with a live storage volume of 7460 million $m^3$ [p2-14], extending 135 km up the Tigris valley [pEXE-8]. The power station will have a capacity of 1,200 MW and is expected to produce 3,800 GWh of power per year [p2-12]. Ilisu has a large active storage area that compensates the highly variable seasonal and annual flow fluctuations in order to generate electricity throughout the year. It is designed as a peaking power plant that will operate to meet the daily and seasonal peak energy needs. Ilisu is therefore planned to operate in conjunction with the Cizre Dam to be constructed 45 km downstream. Cizre will act as a re-regulating reservoir to even out the highly variable peaking power releases and provide for diversion of water to irrigate 121,000 ha of arid lands [p2-2].

Currently, also as part of GAP, there are eleven projects in operation or under construction in the Tigris Basin, of which ten are upstream of Ilisu [p2-11]. These upstream projects cover around 300,000 ha of irrigation land [p4-28], which will result in significant reductions in the river flow before reaching Ilisu. All the irrigation projects upstream and downstream of Ilisu cover a total of approximately 421,000 ha.

In Turkey, the Tigris flows in the southeast for about 400 km, forms the border with Syria for 40 km, and flows downstream to Iraq. The main stem of the Tigris drains an area of 39,000 $km^2$ in Turkey [pEXE-2]. The flow is characterized by a high annual and seasonal variability. The annual mean flow is 520 $m^3/s$ at the border (16.2 billion $m^3$) [p2-12]. The lowest flow was 9.6 billion $m^3$ in 1973, and the highest was 34.3 billion $m^3$ in 1969 [p2-13]. Maximum runoff events spread between November and May. Mean flow in April is 1433 $m^3/s$, while the driest month September is 113 $m^3/s$ [p3-5]. Downstream, at Baghdad, the average flow is 1236 $m^3/s$ (Kliot 1994).

*figure* 1

## Map of the Tigris and Euphrates Watershed

*Source: ArcWorld, USGS EDC*

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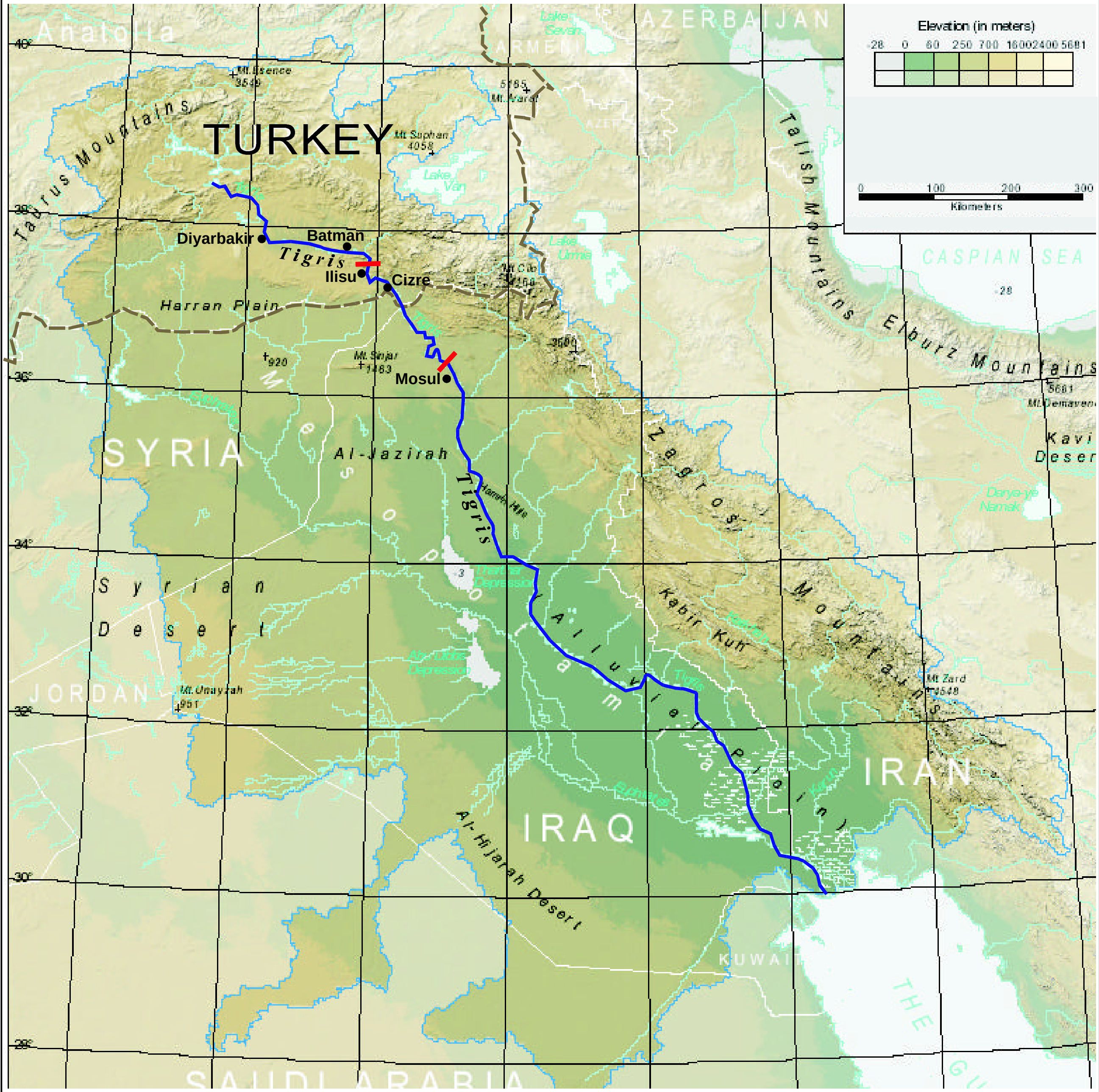

## 4. HYDROLOGIC IMPACTS

The operation of the Ilisu reservoir will substantially alter the flow regime of the Tigris River downstream. In order to generate electricity throughout the year and maximize the potential irrigation diversion downstream, the dam will be operated to store high flows in the spring, make constant releases in the summer growing season, then increase releases to meet higher winter electricity demand. The net effect on flows crossing the border into Syria and Iraq, prior to the completion of the Cizre diversion downstream, is to increase flows in the river in the summer, fall and winter [p4-42], and reduce them in the spring. After completion of the Cizre diversion summer flows would be substantially reduced by irrigation diversions and would probably be reduced below pre-project conditions. Although this significant impact was not addressed in the EIAR, it can be illustrated by subtracting expected irrigation diversions to supply the 121,000ha of the Cizre project from what is represented as the average year flow regime presented in the EIAR. Based on estimated consumptive use of 1.6 m (Kolars and Mitchell 1991) approximately 12 percent of the annual flow would be utilized. Fig 2 and Appendix A shows how average monthly cross border flows would likely be substantially reduced when the combined Ilisu/Cizre project is implemented.

Water users downstream would be most impacted by the reduction in flow frequency –and hence irrigation reliability- as much as the change in average monthly flow rate. Because the full operational simulation of the reservoir was not presented in the EIAR, it is not possible to quantify the increase in frequency of low flows crossing the border. However, because minimum releases from Ilisu during extreme droughts will likely be limited to 60 $m^3$/s it is possible that during drought periods, with full implementation of the Ilisu/Cizre project all the summer flow could be diverted before it crossed the border.

The reliability of flows crossing the border would be further reduced in the future by the cumulative impacts of additional diversions and other components of the GAP scheme, as they are implemented. Approximately 300,000 ha of irrigated land is planned in the catchment area above the Ilisu reservoir [p4-28]. The EIAR significantly underestimates this consumptive use, assuming it to be only 0.5 m of applied water per year [p4-28] instead of approximately 1.6m more typically experienced in semi arid climates and estimated by independent analysis for the GAP area. (Kolars and Mitchell 1991). This more conventional estimate of consumptive use would reduce annual flows by about 29 percent (Appendix A). This future flow reduction could significantly affect the Ilisu reservoir operation resulting in reduced generation in dry years or greater drawdown of reservoir levels in average years exposing approximately 190 $km^2$ of reservoir floor.

During the filling period of Ilisu, the EIAR recommends that discharges downstream be maintained at a minimum flow release of 60 $m^3$/s. If adopted this would create unprecedented low flow conditions downstream more extreme than the worst historic drought. Although the EIAR did not present this information, the effect can be seen by comparing natural flows with planned releases [p4-20] (Figure 2 and 4). The selection of 60 $m^3$/s as the minimum flow release was based on the historic lowest monthly recorded flow at Cizre in September 1960, rather than the minimum of all months in the growing season. It is important to note that since 1960 water use downstream has increased significantly.

In the interim period between completion of Ilisu and completion of Cizre the daily peaking power releases from Ilisu will significantly affect flows downstream. Discharges will change from 4.9 to 1200 $m^3$/sec in less than an hour [p4-35] (In comparison, this flow variation approximates the maximum flood and minimum drought flow recorded on the River Thames at Kingston in the period 1883 to 2000). Even though the EIAR acknowledges that this discharge variation will have negative environmental impacts [p4-35] no hydrodynamic analysis of the attenuation of the daily flood wave downstream is presented, nor is attenuation data from the similar operation of Ataturk Dam presented. Based on a simple dynamic flood routing analysis assuming a typical river channel shape of the Tigris between Ilisu and the Mosul Dam about 160 km downstream, the daily flood surge might only be 16 percent attenuated where it crossed the border (Figure 3).

Although the Ilisu reservoir operation described in the EIAR will result in the capture of the relatively frequent small to midsize floods, it will not control the infrequent large damaging floods. Although the EIAR states 'floods will still occur but with attenuated peaks and with reduced return frequencies' [p4-34], it does not present any analysis of the change in flood frequency due to the project. The Ilisu dam will be operated to maximize power generation revenues and provide a reliable irrigation supply – not for flood control. Large floods, such as the 100yr frequency event cited in the EIAR that has a peak inflow of 11,500 $m^3$/sec [p3-6], would completely fill the reservoir prior to the arrival of the flood crest. The reservoir therefore would not attenuate such a flood event.

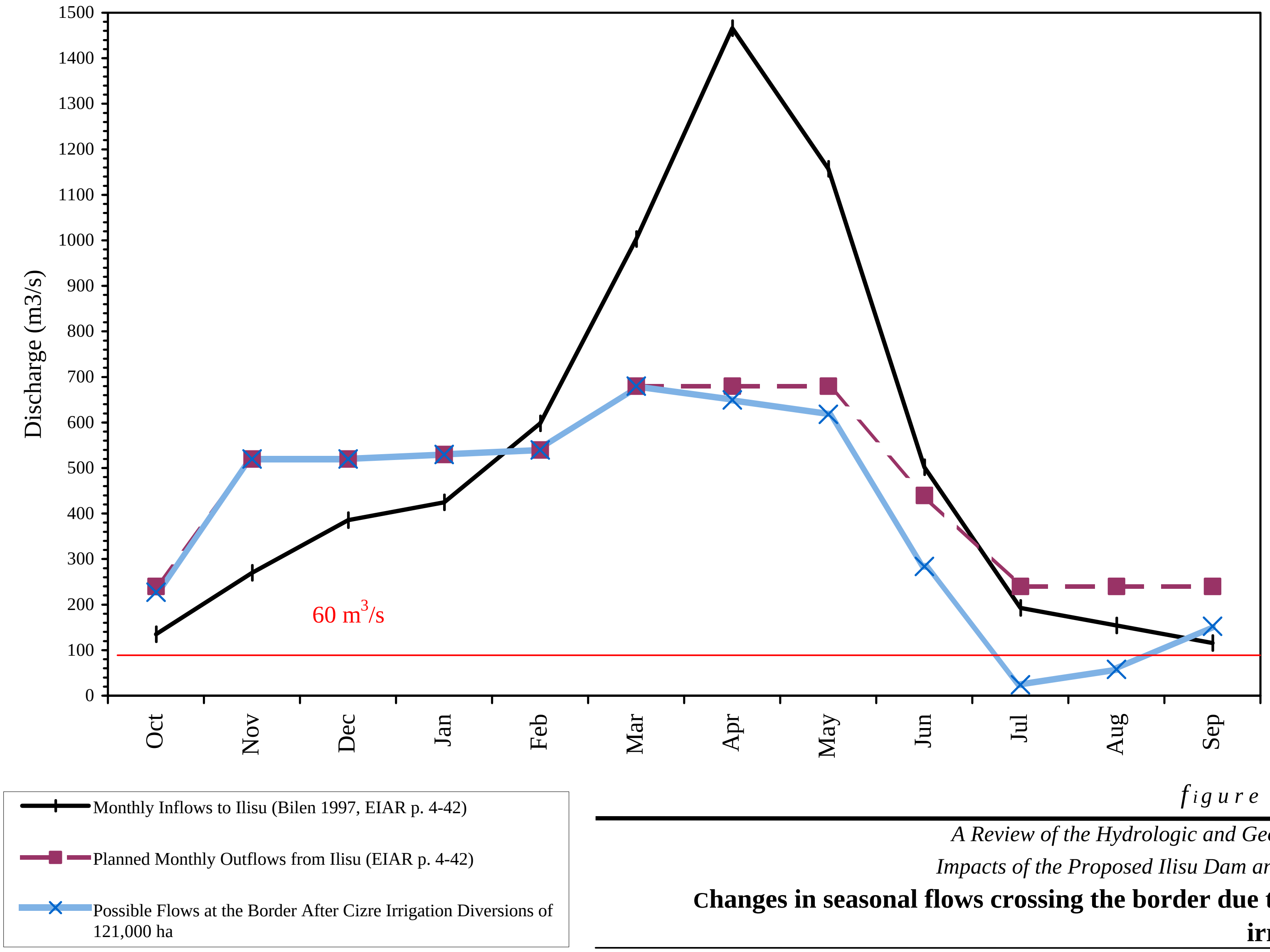


*figure 2*

*A Review of the Hydrologic and Geomorphic Impacts of the Proposed Ilisu Dam and HEPP*

**Changes in seasonal flows crossing the border due to Cizre irrigation**

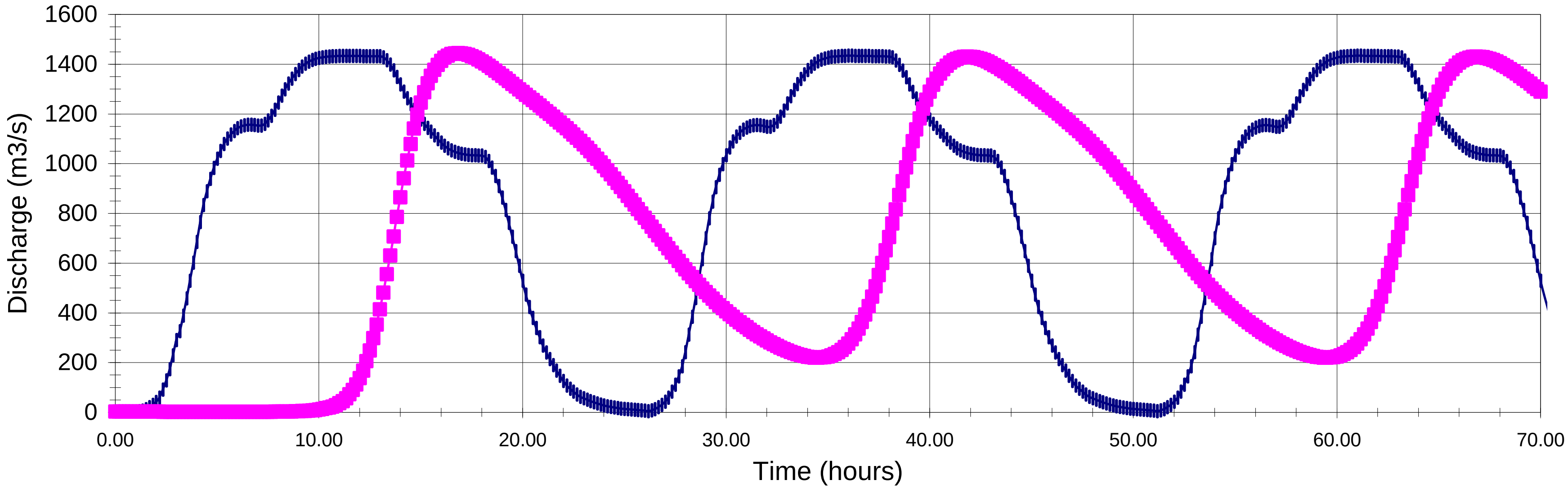


*figure 3*

*A Review of the Hydrologic and Geomorphic Impacts of the Proposed Ilisu Dam and HEPP*

**Attenuation of daily flow fluctuations at the Syrian border**

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The above graph shows the attenuation at the border of daily winter releases from Ilisu, assuming the same winter release schemes as Ataturk Dam (EIAR, p 4-31). The simulation was modeled using one-dimensional hydrodynamic model MIKE-11. The model parameters were obtained from the EIAR and published articles on the Tigris. A roughness coefficient (Manning's n) of 0.04 was used for the channel. Due to lack of data on channel geometry in Turkey, a typical channel cross section downstream of the Mosul Dam in Iraq was used as a surrogate cross section downstream of Ilisu (see Al-Ansari and Rimawi 1997 for channel surveys).

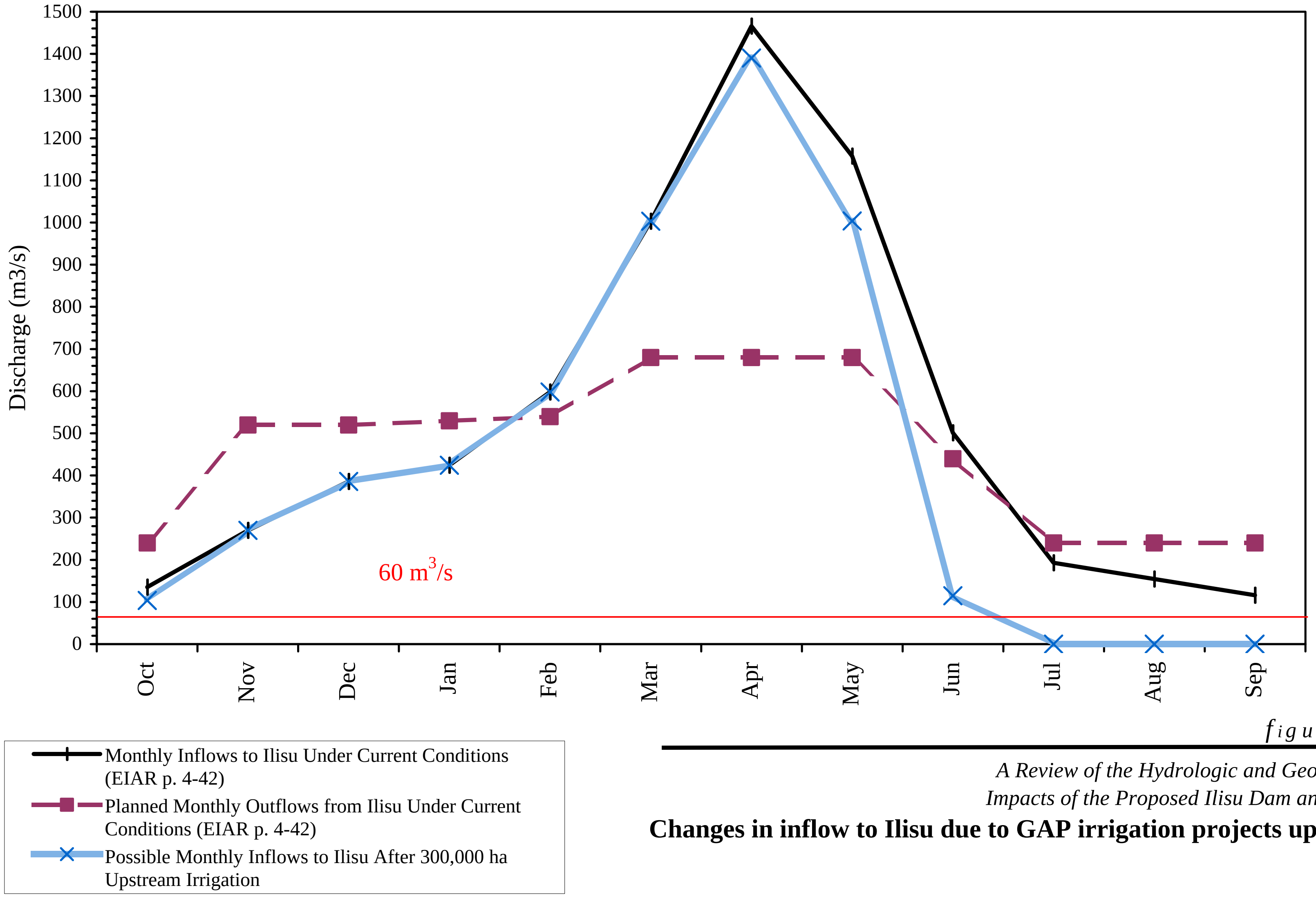


*figure 4*

*A Review of the Hydrologic and Geomorphic Impacts of the Proposed Ilisu Dam and HEPP*

**Changes in inflow to Ilisu due to GAP irrigation projects upstream**

## 5. GEOMORPHIC IMPACTS

The Tigris River conveys large amounts of boulders, sand and mud eroded from the mountain slopes of its catchment. The creation of a large reservoir will capture almost all of this sediment, progressively filling the storage volume and eventually converting it to a marshy alluvial plain. The EIAR estimates average sediment inflow to Ilisu to be 15 to 30 million $m^3$/yr with completion of the Batman dam upstream. The basis for this estimate is not described but appears to be a simple estimate of sediment yield from tributary watersheds of about 500 to 1000 $m^3/km^2$ or about 750 to 1500 tons/$km^2$. This sediment inflow has a high proportion of sand that tends to settle out quickly once it reaches the stagnant water of the reservoir. This proportion is 30 percent based on sampling data [p3-7]

The Ilisu Dam is designed to capture accumulating sediment in the lowest part of the reservoir dedicated as inactive or "dead" storage. This amounts to about 30 percent of the total 10,410 $Mm^3$ reservoir volume [p1-2]. The EIAR does not present a systematic analysis or simulation of reservoir sedimentation and it might be inferred that the reservoir would last 100 to 200 years before the active storage starts to fill. This inference would be mistaken and it is likely that from the beginning of operation, there would be some progressive filling of the active storage as well due to deposition of sand deltas at the mouths of tributary rivers. For the sediment yield cited, this filling would be of the order of 0.1 percent per year, assuming about 30 percent of the inflowing sediment is deposited in the shallower arms of the reservoir. However, it appears that the total sediment inflow may be significantly underestimated in the EIAR. Where watersheds are disturbed by development, erosion rates in semi arid areas can increase significantly – sometimes by two or three orders of magnitude (Newson 1997). Worldwide, there have been many instances where reservoir sedimentation rates have been greatly underestimated –and the importance of this experience has not been discussed in the EIAR. Earlier analysis by the World Bank of this problem indicates that sediment yield for the size of tributary watersheds flowing into the Ilisu reservoir could be in the range 1000 to 10000 tons/$km^2$ (Mahmood 1987, p. 27, Fig 3-1). This would indicate rates of loss of live storage of the order of 0.1 to 1 percent per year. At this higher rate of sedimentation, power production and irrigation deliveries would be significantly impaired within 30 years of the start of reservoir operation.

As sand and boulders accumulate at the mouths of the tributary rivers, they accentuate backwater effects from the reservoir, causing progressive deposition of bed load in the river channel upstream. As the bed level increases, flooding and erosion of floodplains occur and this process of riverbed aggradation will continue upstream until the reservoir has silted in and the river channel can reach equilibrium. Depending on the river slope, these effects can propagate tens of kilometers upstream. (In an extreme case on the Yellow River backwater sedimentation extended 250 km upstream (Morris and Fan 1998)). Unfortunately, the EIAR only anecdotally describes this impact [p4-51] – even though predictive sediment transport models are available to simulate this change and identify the extent of impact upstream.

Within the reservoir, wind wave action and fluctuating reservoir level will erode the reservoir edge. Although the EIAR references this problem [p4-48] it does not indicate its extent. As the reservoir level drops in the winter, it will expose large areas of poorly drained reservoir floor. On an average year approximately 100km$^2$ will be exposed with the initial operation. As upstream irrigation diversions increase and summer inflow diminishes, average year drawdowns would increase if electricity generation were to be maintained, and reservoir floor exposure could increase to 190 km$^2$.

Downstream of the dam the river channel will undergo significant changes – until it is submerged by the Cizre reservoir. Flows discharging from the Ilisu dam will scour the channel bed, causing lowering of the channel and erosion of channel banks. Bank erosion would be further accentuated by the large daily flow fluctuation. Elimination of smaller floods but not larger flood flows would likely cause major channel changes during floods.

## 6. WATER QUALITY IMPACTS

In the catchment above the Ilisu Reservoir, there is a population of 2.9 million, including the City of Diyarbakir as well as 64,000ha of irrigated land. Over the next few decades, the population is expected to increase [p3-65] and the area of irrigated land expands significantly with implementation of GAP. This means that existing high levels of pollution described in the EIAR, which have already created eutrophic conditions in the river [p3-8], are likely to increase. Although the discharge of sewage, pesticides, heavy metals and mining waste products would adversely impact reservoir water quality directly, the most critical concern is the effect high levels of nutrients will have in creating eutrophic conditions in the reservoir. These nutrients are not only contributed by treated or untreated wastewater and fertilizer laden irrigation runoff, but also by soil erosion from the surrounding watershed.

Nutrients washed into the large stagnant Ilisu reservoir will create eutrophic conditions [p4-63]. These nutrients stimulate massive algae growth, which in turn depletes oxygen in the water column. Anoxic conditions in turn release phosphorus bound up in sediments and increase concentrations of hydrogen sulphide, ammonia, iron and manganese. Anoxic conditions also increase the acidity of the water and mobilize heavy metals such as lead and mercury that were bound up in river sediments [p4-60].

These anoxic conditions will persist because of thermal stratification in the reservoir. For much of the year a shallow, warm, more oxygenated layer floats on top of and does not mix with colder anoxic water in most of the reservoir. Therefore discharges downstream will be of anoxic acidic water. Only in the coldest winter months would the reservoir water ‘turn over’, with water exchanging from the top of the reservoir to the bottom.

Eutrophication is likely to cause wide-ranging public health and ecologic impacts. These can include (UNEP 1999):

- Growth of cyanobacteria that are toxic to fish, cattle and humans
- Growth of dinoflagellates or ‘red tides’ that are toxic to humans
- High concentrations of dissolved organic carbon, that when treated with chlorination in downstream water treatment plants produces carcinogenic trihalomethanes
- Growth of floating aquatic plants, whose decomposition produces hydrogen sulphide and methane
- Fish and invertebrates cannot survive in the anoxic zone, but changes in water chemistry induced by anoxia will adversely affect fish throughout the reservoir
- Bioaccumulation of mobilized heavy metals in reservoir fish

The EIAR acknowledges that “serious eutrophication problems” [p4-58] would occur without mitigation measures. The mitigation measures it identifies are the commissioning of wastewater treatment plants in Diyarbakir and other cities, changes in agricultural practices to reduce fertilizers and soil erosion through best management practices (BMPs). Unfortunately the EIAR does not present the kind of systematic limnological analysis that would demonstrate that these measures would prevent eutrophication in the reservoir. Such analyses are recommended in the planning of these kinds of projects (UNEP 1999).

While worthwhile for their own sake, these mitigation measures are unlikely to prevent eutrophication in the Ilisu reservoir for the following reasons:

- Planned sewage treatment plants will improve water quality but not remove nutrients [p3-11].
- A significant portion of nutrients flowing into the reservoir will come from areas not affected by BMPs or from the soils in the reservoir zone.
- A significant amount of nutrients derived from agricultural sources would have already accumulated in the reservoir before the BMPs could take effect.
- Anoxic conditions will release additional nutrients from sediments.
- Once eutrophication has occurred nutrients would be recycled within the reservoir. It could take decades for levels to diminish even if nutrient inflows were substantially diminished.

Eutrophication would have significant adverse impacts on water quality downstream. This is recognized in the EIAR [p4-63] but not quantified – even though predictive models are available that would determine how far downstream key variables, such as dissolved oxygen, would be adversely impacted.

With the completion of the Cizre reservoir, there would be cumulative impacts on water quality. Releases from Ilisu would flow directly into a second stagnant reservoir pool and there would be little re-aeration downstream. Thus poor quality water would be transmitted directly from Ilisu to the Syrian border.

## 7. ENVIRONMENTAL IMPACTS OF PHYSICAL CHANGES

Although this review is focused on the direct physical impacts of the dam and its operation, these impacts will directly affect other environmental values. Among the most important are:

*Downstream water supply*

Water supply for irrigation and urban uses in Syria and Iraq could be significantly and adversely affected. As stated in the hydrologic impact sections, total flows will be diminished after completion of the Cizre project, and it appears that during drought periods cross border flow releases from Ilisu in the growing season would be limited to 60 $m^3$/sec if the Turkish government were to adopt the recommendation of the IEG [pEXE-18]. The basis for recommending this flow rate appears to be that it equals the lowest recorded monthly flow at Cizre in September 1960, but the EIAR also cites 'the needs of the downstream population as well as the topographic and ecologic conditions' in determining this flow rate [pEXE-18]. No further substantiation of this minimum flow recommendation is provided in the EIAR. It is likely that the needs of the downstream population will not be met by a 60 $m^3$/s flow because this population has grown significantly since 1960, and because this minimum flow could apply for the whole season instead of one month.

In addition, because of reservoir eutrophication, downstream water quality will likely be significantly impaired requiring upgraded and more sophisticated water treatment. This is acknowledged by the EIAR, which states that "the impact of the project on the water quality released downstream is considered significant and might be a limiting factor for the downstream water use" [p4-63].

*Public safety*

It is likely that because small and moderate floods will be eliminated, long-term flood damages will increase downstream because extreme floods will not have been eliminated. Typically reduction in flood frequency will induce people to settle on the floodplains and along the river channel in the mistaken belief that the Ilisu dam would have eliminated all flood risk. The EIAR does not present an analysis of the change in flood hazard that would inform governmental agencies downstream.

In addition sedimentation in the rivers discharging into the reservoir will increase flood levels affecting villages upstream of the reservoir [p4-48]. However, no analysis of this problem is presented.

The EIAR acknowledges the low but finite risk of catastrophic dam failure [p4-29] but understates its devastating consequences. The release of 10 billion $m^3$ "within a few hours" [p4-29] would create a flood wave of the order of 1,000,000 $m^3$/s. Such a floodwave would probably breach the Cizre and Mosul dams downstream and devastate the cities of Cizre, Mosul and Baghdad. The EIAR does not present a dam break analysis to identify the downstream area at risk as is recommended for a large project of this type (ICOLD 1987)

*Public health*

The EIAR acknowledges that seasonal reservoir drawdown will expose large areas of shallow ponded water creating good habitat for disease vectors such as mosquitoes [p4-7]. These conditions would also occur for many kilometers along the valleys in the backwater zones of the tributary rivers. Under average operating conditions initially more than 100 $km^2$ of reservoir bed will be exposed and during dry years more than 190 $km^2$ will be exposed. As summer inflows are reduced by upstream irrigation, the probability of this larger drawdown area will increase. In addition the stagnant eutrophied condition of the reservoir during the summer would likely further stimulate water borne diseases. This has been identified as a serious concern for GAP water projects by independent observers (Aksoy et al. 1995, Appendix C). Pesticides and heavy metals would tend to accumulate in those fishes that survive eutrophication and reservoir turnover events. If consumed by humans, this could pose a public health threat. This issue was not addressed in the EIAR

*Greenhouse gas emissions*

Eutrophication and anoxic conditions in the reservoir will generate methane from the anaerobic decomposition of organic matter. (WCD 2000) It is likely that these greenhouse gas emissions from the reservoir will be substantially greater than those emitted by the arid natural landscape of the reservoir site. While the EIAR acknowledges that greenhouse gases will be emitted [p4-9], their impact is not discussed.

## 8. ADEQUACY OF THE ILISU DAM EIAR

The purpose of the EIAR is to allow full consideration of the environmental impacts of the project [p1-7] by relevant authorities. To accomplish this goal requires that the EIAR provide an analysis based on an understandable and logical methodology, that the information is accurate, complete, and unbiased, and that the conclusions are justified. In addition, it is reasonable to expect that for a project of this magnitude and importance to the Turkish economy, the appropriate level of scientific analysis has been applied to understand the possible environmental impacts, so that design malfunctions, alternatives, and mitigation measures can be properly considered. Finally, potential international funders of the project are interested in determining whether current international standards and guidelines have been followed in the preparation of the EIAR.

Only by preparing such a comprehensive environmental impact assessment can the true costs and benefits for government, investors, and local people be determined and evaluated.

The following are our comments and recommendations based on our review of those sections of the EIAR that deal with key physical impacts.

*Are the EIAR conclusions justified?*

Our analyses raised the following concerns regarding the justification of the EIAR's conclusions:

1. *Unsubstantiated Information*

   The EIAR does not provide any information to substantiate some key conclusions. Specifically:

   - There is no validation for the "downstream release rules" [p4-20]. The determination that a 60 $m^3$/sec flow "secures sustainable conditions downstream" [pEXE-16], or is "sufficient to ensure environmentally acceptable conditions", is speculative and unjustified [p4-37].
   - There is no substantive information on reservoir siltation rates. The section in the Executive Summary does not present any quantitative information [pEXE-8] and is open to interpretation. A more detailed analysis is provided in the main report. However the sediment yield numbers chosen could be at the low end of the range and could significantly underestimate the loss of reservoir storage [p4-50].
   - EIAR refers to the "reduction of the damages caused by floods" as a positive downstream impact without presenting any evidence [p4-38].
   - The report acknowledges the significant adverse impacts on downstream water quality. However, the discussion and the conclusions presented are inadequate. The impacts table is incomplete and there is no justification for the evaluation criteria for the parameters [p4-63].

2. *Contradictory Information*

- The EIAR is inconsistent with respect to the relationship between Ilisu and Cizre Projects. In one part it claims that "…Ilisu does not depend on the implementation of Cizre" [p2-13], while elsewhere it states "….the construction of the Cizre project had to be considered to better regulate the discharges downstream of Ilisu" [p2-16], "…. Cizre is the natural complement of Ilisu…" [p4-46], and "…the implementation of Cizre will be soon so that Ilisu will most probably not be operational without Cizre." [p4-37].

- The EIAR provides contradictory information on the role of the wastewater treatment plants in the reservoir water quality. In the Executive Summary, it is stated that "the eutrophication will occur if the discharge of untreated waste water from Diyarbakir, Bismil, …are not mitigated", and later on that "the Diyarbakir waste water treatment plant will be operational before impounding of the reservoir" [pEXE-16], thus implying that the Diayrbakir plant will mitigate the deteriorated water quality of the reservoir. The EIAR further states that "[first and second stage treatments] will enable a sufficient level of oxygen to be maintained for aquatic life". However, "The design of the Diyarbakir waste water treatment plant does not include a tertiary treatment and will therefore not contribute to the removal of nitrogen and phosphorus", which are the major nutrients stimulating eutrophication [p4-55]. The commissioning of the Diyarbakir water treatment plant will only slightly remedy the adverse impacts, and the eutrophic conditions will prevail.

3. *Incomplete Information*

The EIAR fails to analyze important factors that would influence its conclusions. Specifically:

- The impact of reservoir operation on downstream flows is not presented as a change in the seasonal flow hydrograph, or of flow frequency, based on a reproducible set of reservoir operational simulations. Instead of presenting a rigorous synthesis of this data, only a few selected hydrographs are presented.

- Except a few references to Cizre Dam construction, the EIAR does not consider or evaluate the cumulative impacts of the combined Ilisu and Cizre schemes downstream and cross the border (see "Is the EIAR unbiased" discussion below).

- Changes in inflows to the reservoir due to upstream irrigation and associated downstream impacts are not evaluated. Such changes could significantly alter the rate and volume of releases downstream.

- There is little mention of the scouring of the riverbed downstream. The EIAR states that "the existing gravel bars along Tigris between Ilisu and Cizre might be partly eroded as long as the Cizre reservoir is not impounded". River bed and bank incision downstream of the dam will almost certainly happen. As a drastic example, the bed of the Colorado River was lowered more than 4 meters at some places after the closure of the Hoover Dam (McCully 1996).

- Upstream bedload transport analysis recognizes that there will be deposition at the confluences with the tributary rivers and at the reservoir tails, however the flooding impacts due to aggradation are not analyzed [p4-51].

We recommend that data and analyses used to develop significant conclusions should be provided in the text or as appendices.

*Does the EIAR follow an understandable and logical methodology?*

We find that there are six significant methodological flaws that seriously limit the usefulness of the report:

- The definition of the 'project' is unclear and contradictory

  The EIAR provides inconsistent information about the nature of the projects, and as mentioned earlier, about the relationship between Ilisu and Cizre projects. Ilisu is initially defined as a "pure energy project" [p2-12]. Emphasis is further added to this statement by claiming that "Ilisu does not depend on the implementation of Cizre" [p2-13]. However, the EIAR contradicts that claim by referring back to the initial feasibility studies of 1982, which concluded that the "Cizre project had to be considered to better regulate the discharges downstream of Ilisu" [p2-16]. Also it is acknowledged that "Cizre is the natural complement of Ilisu" [4-46].

- Cumulative impacts are not analyzed

  The EIAR contains no discussion on the cumulative environmental impacts of the dams planned on the Tigris or of Ilisu's likely contribution to these impacts. The EIAR justifies this on the grounds that "their evaluation would have required a much larger database and because this task should be undertaken within the framework of regional planning" [p1-1]. The EIAR specifically acknowledges that it is evaluating only "an element of [the] regional plan" [p1-1].

  This inadequacy was previously noted by Environmental Resources Management, the consultants who prepared the UK government's assessment of the draft EIA. ERM specifically highlights cumulative impacts as one of the issues that the EIAR should address and warns that these impacts could be "significant, to the extent that special mitigation measures may be appropriate" (ERM, p.2, para 1.3)

- Transborder impacts are not included

  The EIAR provides no information regarding basic environmental conditions downstream of the dam, in Syria, and Iraq. Detailed information on the environment of downstream riparian countries could be difficult to obtain, however, there is not even mention of an outline description of existing land-use patterns, physical attributes of the river, or significant features such as the Mosul Dam about 100 km downstream. The only attempt to identify possible cross border impacts is with reference to the benefits of flow regulation downstream, ignoring the discussion on the impacts of flow reductions and fluctuations to the river system downstream, and the impacts on existing reservoir operations.

- Impacts are not analyzed over the lifetime of the project, nor is the lifetime of the project discussed.

- Impacts are assumed to be mitigated by actions outside the cope of the narrowly defined project.

Best Management Practices (BMPs) are presented as the mitigation measures, “which can prevent or slow down the reservoir eutrophication process” [p5-3]. Development and implementation of such a watershed management plan needs to be considered as part of the overall environmental assessment, and such a plan should describe concrete measures to manage and control upstream soil erosion and river pollution. Similarly, it is essential that the water treatment plants are considered as an integral part of the impacts assessment and that more detailed information is provided on their design and capacities, and their role in mitigating the water quality in the reservoir and the river downstream.

- The EIAR is essentially a post-project assessment of the plan that was developed more than twenty years ago, before the importance of environmental factors were recognized as constraints on the achievement of development goals. It does not appear that any design or operational modification has been made to the 1982 plan as a result of this assessment.

We recommend that prior to decisions to proceed with the Ilisu, a rigorous, comprehensive, programmatic environmental assessment be carried out on all GAP projects within the Tigris catchment as an integral part of GAP project planning. This EA would examine cumulative hydrologic, water quality and geomorphic impacts both within Turkey and downstream over the lifetime of the project. As part of this assessment, mitigation measures would be identified that would be fully incorporated into GAP design and operation. The assessment would also identify those impacts that cannot be mitigated.

*Is the EIAR based on accurate data?*

In conducting this review, we have had to rely extensively on the information presented in the EIAR. Source materials and data cited by the EIAR were not made available to us to enable us to check the quality of the information presented in the document (Appendix B).

We recommend that an assessment of this information be subject to an independent peer review process and that source materials be made subject to public review.

*Is the EIAR unbiased?*

For an environmental assessment of this importance, it is essential that its findings and conclusions are fair and substantiated by the evidence. For this EIAR, the circumstances of its preparation make it difficult to avoid bias. The Ilisu Engineers Group has been hired directly by the Ilisu contractors, the project proponents, and their terms of reference have not been disclosed. For this EIAR, we find several instances of apparent bias that we believe undermines the credibility of its conclusions. This bias is towards ignoring, diminishing or obfuscating important negative environmental impacts. Specifically:

- By failing to address trans-boundary impacts and cumulative hydrologic impacts the EIAR does not disclose major potential negative impacts.

- In the analysis of environmental impacts a section is included on ‘benefits for the downstream environment’ that makes definitive statements about positive impacts [4-38], but provides no equivalent section summarizing potential adverse impacts.

- Important information is presented in a way that misleads the reader of the potential scale of negative impacts. For example: The discussion of dam failure describes the high velocity flows but not the massive flood wave. It states ‘the Cizre bridge might be destroyed’ [p4-29], a statement that tends to trivialize the potential devastating impact. Another example is the discussion of downstream channel erosion that by stating ‘existing gravel bars …might be partly eroded’ [p4-52] significantly diminishes the scale of the impact.

- A matrix of impacts is presented [table 6-1] ‘determined by the IEG expert team’ [p6-3] that rated eutrophication of the reservoir as a ‘medium negative impact’ on water quality, and a ‘high positive impact ‘ on plankton.

We recommend that the preparation of an EIAR of this type be carried out by independent, qualified environmental assessment professionals, contracted directly by governmental or international agencies.

*Was the appropriate scientific analysis used in analyzing impacts?*

In our review we have identified a number of important impacts that could be better determined if contemporary analytic methods were used. It is not clear why, for a project of this magnitude, the best scientific knowledge is not being utilized. Specifically:

- Reservoir limnological models to predict circulation and water quality
- Water quality models for downstream river flow
- Dynamic flow models to predict attenuation of peaking releases
- River sediment transport models to predict aggradation

*Does the EIAR fulfill the requirements of the Ex-Im Bank Guidelines?*

Although the Ex-Im Guidelines do not specifically require a systematic integrated environmental assessment methodology as is now generally accepted worldwide (WCD 2000), these guidelines make it clear that a project’s merits will be evaluated against specified environmental objectives. The relevant objectives for this review are:

*2. Water use and Quality. Protection of surface and groundwater resources from over demand and project related contamination*

*4. Natural hazards. Siting and design of the project to acceptable levels of natural, ecologic, and economic risk*

*5. Ecology. Protection of ecological resources, encouragement of conservation, and promotion of practices that result in the reduction of greenhouse gases.*

In addition, specifically for hydropower projects the guidelines require ‘All potential environmental effects and measures to mitigate these effects must be adequately identified’

Our review concludes that the EIAR does not adequately identify all environmental impacts as required by Ex-Im because:

> *Water use and quality*. The EIAR does not quantify or provide a hydrologic analysis of the impacts on flows across the border downstream, when it is clear that the project will likely create over-demand. The EIAR does not quantify or present reservoir water quality simulations to determine how severe water quality and public health impacts will be for the population around the reservoir or downstream, when it is clear that the reservoir will likely contaminate water supplies.
>
> *Natural hazards*. The EIAR does not identify the area of influence at risk from dam failure and is dangerously misleading when it implies that large floods will be reduced downstream.
>
> *Ecology*. The EIAR does not quantify upstream and downstream river channel changes that have significant impacts on ecosystems. It does not address greenhouse gas emissions. A watershed management plan is discussed but not developed. No mechanism for implementing the plan is identified. Cumulative impacts are not evaluated.

*Does the EIAR follow contemporary environmental assessment methodology?*

The EIAR acknowledges it could not attain full compliance with World Bank, OECD or contemporary Turkish government regulations that were enacted after the project was designed [p1-7].

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http://www.gap.gov.tr

# APPENDIX A

## Estimate of Flow Changes

Mean monthly flow of the Tigris at Cizre (Bilen, O. 1997. Turkey and Water Issues in the Middle East. GAP Regional Development Administration)

| | billion m3 | cms |
|---|---|---|
| Oct | 0.35 | 135.0 |
| Nov | 0.7 | 270.1 |
| Dec | 1 | 385.8 |
| Jan | 1.1 | 424.4 |
| Feb | 1.55 | 598.0 |
| Mar | 2.6 | 1003.1 |
| Apr | 3.8 | 1466.0 |
| May | 3 | 1157.4 |
| Jun | 1.3 | 501.5 |
| Jul | 0.5 | 192.9 |
| Aug | 0.4 | 154.3 |
| Sep | 0.3 | 115.7 |
| | 16.6 | 6404.3 |

**VERIFICATION FROM KLIOT (1994):**

**Flows at Mosul**

Flows at Mosul is 1.1 times the flows at Cizre (16.6 vs 18.4)

| | billion m3 | m3/s | billion m3 | m3/s | | m3/s |
|---|---|---|---|---|---|---|
| Jan | 1.26 | 486.11 | 1.15 | 441.92 | Oct | 157.83 |
| Feb | 1.98 | 763.89 | 1.80 | 694.44 | Nov | 231.48 |
| Mar | 2.5 | 964.51 | 2.27 | 876.82 | Dec | 315.66 |
| Apr | 3.96 | 1527.78 | 3.60 | 1388.89 | Jan | 441.92 |
| May | 3.42 | 1319.44 | 3.11 | 1199.49 | Feb | 694.44 |
| Jun | 1.68 | 648.15 | 1.53 | 589.23 | Mar | 876.82 |
| Jul | 0.82 | 316.36 | 0.75 | 287.60 | Apr | 1388.89 |
| Aug | 0.45 | 173.61 | 0.41 | 157.83 | May | 1199.49 |
| Sep | 0.32 | 123.46 | 0.29 | 112.23 | Jun | 589.23 |
| Oct | 0.45 | 173.61 | 0.41 | 157.83 | Jul | 287.60 |
| Nov | 0.66 | 254.63 | 0.60 | 231.48 | Aug | 157.83 |
| Dec | 0.9 | 347.22 | 0.82 | 315.66 | Sep | 112.23 |
| | 18.4 | | 16.73 | | | 6453.42 |

Kolars and Mitchell (1991)

"Irrigation Water Needs" in the Euphrates Basin from GAP 1980

| | m3/ha/mo | m/mo |
|---|---|---|
| April | 405.34 | 0.041 |
| May | 832.87 | 0.083 |
| June | 2090.56 | 0.209 |
| July | 2890.21 | 0.289 |
| August | 2438.08 | 0.244 |
| September | 1169.28 | 0.117 |
| October | 172.37 | 0.017 |
| | 9998.71 | 1.000 |

After taking into acount potential evapotranspiration with losses ie amount withdrawn (2.5 times PE) and the return flow (35% of the amount withdrawn) the amount becomes 1.6 m (1*2.5 -(2.5*0.35)=1.6) (Kolars and Mitchell)
Asuming the same distribution for the Tigris Basin with corrected consumptive use:

| | | 121,000 ha | | 300,000 ha | |
|---|---|---|---|---|---|
| | m/mo | m3/mo | m3/s | | |
| April | 0.0656 | 79,376,000 | 30.62 | 196,800,000 | 75.93 |
| May | 0.1328 | 160,688,000 | 61.99 | 398,400,000 | 153.70 |
| June | 0.3344 | 404,624,000 | 156.10 | 1,003,200,000 | 387.04 |
| July | 0.4624 | 559,504,000 | 215.86 | 1,387,200,000 | 535.19 |
| August | 0.3904 | 472,384,000 | 182.25 | 1,171,200,000 | 451.85 |
| September | 0.1872 | 226,512,000 | 87.39 | 561,600,000 | 216.67 |
| October | 0.0272 | 32,912,000 | 12.70 | 81,600,000 | 31.48 |
| | 1.6 | 1.94E+09 | | | |

UPSTREAM
Average monthly flows after consumptive use for irrigation of 300,000 ha
Flows from Bilen

| | | Irrigation Use | Inflows | Inflows w/o negative | * Even with 1 m of consumptive use (conservative assumption) | | |
|---|---|---|---|---|---|---|---|
| | m3/s | m3/s | m3/s | m3/s | m/ha/mo | m3/s | |
| Oct | 135.03 | 31.48 | 103.55 | 103.55 | 0.017237 | 19.95023 | 115.08 |
| Nov | 270.06 | | 270.06 | 270.06 | | | 270.06 |
| Dec | 385.80 | | 385.80 | 385.80 | | | 385.80 |
| Jan | 424.38 | | 424.38 | 424.38 | | | 424.38 |
| Feb | 597.99 | | 597.99 | 597.99 | | | 597.99 |
| Mar | 1003.09 | | 1003.09 | 1003.09 | | | 1003.09 |
| Apr | 1466.05 | 75.93 | 1390.12 | 1390.12 | 0.040534 | 46.91435 | 1419.14 |
| May | 1157.41 | 153.70 | 1003.70 | 1003.70 | 0.083287 | 96.39699 | 1061.01 |
| Jun | 501.54 | 387.04 | 114.51 | 114.51 | 0.209056 | 241.963 | 259.58 |
| Jul | 192.90 | 535.19 | -342.28 | 0.00 | 0.289021 | 334.515 | -141.61 |
| Aug | 154.32 | 451.85 | -297.53 | 0.00 | 0.243808 | 282.1852 | -127.86 |
| Sep | 115.74 | 216.67 | -100.93 | 0.00 | 0.116928 | 135.3333 | -19.59 |

DOWNSTREAM
Average flows from EIA [4-42]

| | | | |
|---|---|---|---|
| | m3/s | | |
| Oct | 240 | 12.70 | 227.30 |
| Nov | 520 | | 520.00 |
| Dec | 520 | | 520.00 |
| Jan | 530 | | 530.00 |
| Feb | 540 | | 540.00 |
| Mar | 680 | | 680.00 |
| Apr | 680 | 30.62 | 649.38 |
| May | 680 | 61.99 | 618.01 |
| Jun | 440 | 156.10 | 283.90 |
| Jul | 240 | 215.86 | 24.14 |
| Aug | 240 | 182.25 | 57.75 |
| Sep | 240 | 87.39 | 152.61 |

UPSTREAM+DOWNSTREAM

| | | | | |
|---|---|---|---|---|
| Oct | 103.55 | 12.70 | 90.85 | 90.85 |
| Nov | 270.06 | | 270.06 | 270.06 |
| Dec | 385.80 | | 385.80 | 385.80 |
| Jan | 424.38 | | 424.38 | 424.38 |
| Feb | 597.99 | | 597.99 | 597.99 |
| Mar | 1003.09 | | 1003.09 | 1003.09 |
| Apr | 1390.12 | 30.62 | 1359.50 | 1359.50 |
| May | 1003.70 | 61.99 | 941.71 | 941.71 |
| Jun | 114.51 | 156.10 | -41.60 | 0.00 |
| Jul | 0.00 | 215.86 | -215.86 | 0.00 |
| Aug | 0.00 | 182.25 | -182.25 | 0.00 |
| Sep | 0.00 | 87.39 | -87.39 | 0.00 |

# APPENDIX B

## Correspondences with the IEG

HYDRO CONCEPTS
ENGINEERING
MAUR SWITZERLAND

RECEIVED
AUG 17 2001
BY:

PWA
Tamalpais Drive 770 Suite 401
Corte Madera
CA 94925-1739 USA

Maur, 01.08.12,

**Ilsu EIAR**

Gentlemen,

With reference to your letter dated 01.07.30, we inform you that the documents you are looking for are not IEG property and originate from various sources; many of them could not even be copied and had to be consulted in the files of governmental offices or other organizations reluctant to disclose them. To provide copies now would first need the permissions of those organizations having finally accepted to put them at our disposal for the elaboration of the EIAR and this would require in turn to know first who appointed you for your review of this report and what is the exact purpose of it.

Provided the required permissions could be granted, which is not sure for all documents, you must understand that the collection of these records will require some efforts for traveling in the Project area, copying and postage, so that we would also need your confirmation that you would be prepared to compensate us at cost for all the expenses resulting therefrom.

Yours faithfully

HYDRO CONCEPTS ENGINEERING

Gavard

M. Gavard

Twäracher 1 CH 8124 Maur, Switzerland Phone: ++41 1 980 20 30 Fax: ++41 1 980 20 63 Mobile Phone ++41 79 400 48 61 e-mail:

TELEFAX MESSAGE

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# DOLSAR

## ENGINEERING LIMITED

Dolsar Building, Kennedy Caddesi 43, 06660 Ankara - TURKEY
Tel: (312) 417 9000 Telefax : (312) 418 1066
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Fax message No: 263

File : 544

From: H. Irfan Aker

No. of pages (including this page): 1

To: PWA -
Attn: Mr. Philip B Williams, Ph.D., P.E., Eur. Ing.
President

Date: 13 August 2001
Fax : 00 1 415 945 0606
Tel : 00 1 415 945 0600

**IF YOU HAVE NOT RECEIVED ALL PAGES, PLEASE CALL (TR) (312) 417 9000**

**SUBJECT:** ILISU EIAR

Dear Mr. Williams,

- Thank you for your fax message of 8.10.01.
- Hydro Concepts Engineering (HCE) is the leader of our consortium
- We understood that Mr. M. Gavard answered your request by his fax message of 12.08.01.
- We will follow the instruction of HCE.

Best regards,

H. Irfan AKER /DOLSAR

**COLENCO**

*Colenco Power Engineering Ltd*

**TELEFAX** 3. August 2001

**To:** Philip Williams & Associates (PWA)
Mr. Philip B. Williams, President

**Fax-Number:** +1 415 945 0606

**Copy to:**

| | |
|---|---|
| VATECH – Mr. P.G. Haas | 01 278 28 19 |
| HCE – Mr. M. Gavard | 01 980 20 63 |
| Dolsar – Mr. H. Irfan Aker | +90 312 418 10 66 |

**From:** G. Resele
Tel. ++41 56 483 18 00
Fax ++41 56 493 73 57
eMail georg.resele@colenco.ch

**Number of pages:** 2 (+ 2 for others than PWA)

**Ilisu Dam Environmental Impact Assessment References**
**your letter PWA Ref.#01-090 from July 30th, 2001**

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Dear Mr. Williams

due to the large amount of technical documentation that had to be evaluated for preparing the EIAR and due to the fact that many of these were to be studied by several persons in parallel, the technical work was mostly done centralised at the office of Dolsar in Ankara, using and further extending its library, its collection of documents on the Ilisu Project and of those on other related projects (e.g. GAP). Copies of these documents were not produced, apart from very selective extracts. The documents listed in your letter are therefore not available at Colenco.

The documents you identified to be necessary for your review must be requested at Dolsar. Whether it's possible for Dolsar to send you the documents, copies of the documents or whether you have to consult them at Ankara is beyond my information and my responsibility.

I'm very sorry not to be in a position to respond to your letter in another way. Please feel free to contact us if you have any technical questions (with copy to HCE – Mr. M. Gavard).

*Colenco Power Engineering Ltd*
*Mellingerstrasse 207, CH-5405 Baden/Switzerland*
*Telephone ++41 56 483 12 12, Telefax ++41 56 493 73 55*
*info@colenco.ch http://www.colenco.ch*

COLENCO

Colenco Power Engineering Ltd



Sincerely,

*Colenco Power Engineering Ltd.*

Dr. Georg Resele
Chief Project Manager

Enclosure: Letter PWA Ref.#01-090 from July 30th, 2001 to Colenco

PWA
PHILIP WILLIAMS & ASSOCIATES
CONSULTANTS IN HYDROLOGY
770 TAMALPAIS DRIVE, SUITE 401, CORTE MADERA, CA 94925-1739
TEL: 415.945.0600 FAX: 415.945.0606
E-MAIL: SFO@PWA-LTD.COM

July 30, 2001

Mr. Irfan Aker
Dolsar Engineering Ltd.
Kenndy Caddesi. No:43
Kavaklidere
0660 Ankara
Turkey

RE: **Ilisu Dam Environmental Impact Assessment References**
PWA Ref. # 01-090

Dear Mr. Aker:

We have been engaged to review the Ilisu Dam and HEPP Environmental Impact Assessment Report (April 2001) concerning hydrological impacts. In reviewing the EIA, we have noted the following references in the Report.

1. Dolsar Muhendislik Limited Sirketi. 1997. *Dicle-Ilisu Operation Study* (# 31)
2. Dolsar Engineering Ltd. 1997. *Ilisu Dam and Hydroelectric Power Plant Project, Summary Report*, Ankara, pp 17+11 figures (# 30)
3. *Ilisu Dam and Hydroelectric Power Plant Project Interim Report*, September 1997 (# 83)
4. Ilisu Hydropower Consultants: *Ilisu Dam and HEPP and Cizre Dam and Hydroelectric Plant Project, Loan Application Report*, 1983 (# 84)
5. Ilisu Hydropower Consultants: Design Reports, Volume 1. *Technical and Economical Feasibility Report*, December 1977 (# 86)
6. Ilisu Hydropower Consultants. Ilisu Dam and HEPP Project Design Reports Volume 12, *Reservoir Operation*, July 1982 (# 99)
7. Temel Consulting Eng. Inc. *Dicle-Ilisu Project, Dicle Project Feasibility Report*, Vol 1, 1977 (# 163)
8. Temel Consulting Eng. Inc. *Dicle-Ilisu Project Feasibility Report, Hydrology*, Vol 11, 1977 (# 164)
9. GAP. Republic of Turkey, Prime Ministry, Southeastern Anatolia Project, Regional Development Administration; *Status Report*, June 2000 (#265)
10. Dicle University. *GAP Region Environment Study Dicle Basin (Environmental Study for Diyarbakir and Surroundings). Executive Summary*. Mart 1993 (# 24)
11. EIE. *Dicle Ilisu Baraj Rezervuari Kamulastirma Raporu (Revize 1979) (Dicle-Ilisu Dam Reservoir Expropriation Report) (Revised in 1979)*. Prepared by the Directorate of Sediment Survey Technical Commission. Pp 36. 1979 (# 45)
12. Repuclic of Turkey, Prime Ministry GAP Regional Development Administration. *Recent Situation in the Southeastern Anatolia Project*. Pp 32. October 3, 1977 (# 145)

In order to complete our review, we need to obtain the above referenced documents. Further, because of time constraints we need access to these documents as expeditiously as possible. We would much appreciate it if you would immediately forward those referenced documents that you have in your possessions. If there are some documents that you do not have, please let us know where and how we can get them.

Thank you for your cooperation in this matter. We look forward to hearing from you shortly.

Sincerely,

Philip B. Williams, Ph.D., P.E., Eur. Ing.
President

# APPENDIX C

## Emerging Infectious Diseases in the GAP Region

## The GAP Project in Southeastern Turkey: The Potential for Emergence of Diseases

**To the Editor:** The undersigned, representing interested scientists from both Turkey and the United States, recently visited the water development projects in southeastern Anatolia, Turkey. This letter describes our observations and projections on the possible health-related consequences of these projects with specific emphasis on infectious diseases.

When new irrigation schemes are introduced into previously dry areas, disease frequently follows the new water. The Southeastern Anatolia Irrigation Project or GAP (its Turkish acronym) is one of the largest projects ever undertaken in Turkey. This water resources development program includes the construction of 22 dams and 19 hydroelectric plants on the Euphrates and Tigris rivers in southeastern Turkey. Upon completion, the project will also include an irrigation network for 1.7 million hectares of land, covering eight provinces corresponding to approximately 10% of Turkey's total population and surface area (1). In its entirety, GAP comprises investments in development projects linked to agriculture, energy, transportation, telecommunications, health care, education, and urban and rural infrastructures. To ensure the success of the project, an agency has been established (the Republic of Turkey Prime Ministry Southeastern Anatolia Project Regional Development Administration) to oversee and implement all of these projects.

The largest of the completed dams on the Euphrates River is the Ataturk Dam. It is the sixth-largest rock-filled dam in the world; its hydroelectric systems have already produced more than seven billion kilowatt hours of power since 1992 (2). Water from the Ataturk Dam reservoir is diverted to the plains of upper Mesopotamia through the Sanliurfa Irrigation Tunnel System. This system consists of two parallel tunnels, each 26.5-km long and 7.62 m in diameter, and numerous other irrigation networks and canal systems. The first water started to flow to the plains of Harran in November 1994. Additional lands will be incorporated into the irrigation scheme as the canals are completed. (The year 2020 is the target date for completion.) When fully operational, GAP is expected to double Turkey's hydroelectric production, increase irrigated areas by 50%, more than double the per capita income in the region, more than quadruple the gross national product, and create two million new jobs in the coming decade (3). The total surface area affected by the irrigation scheme is about 75,000 km$^2$; of this, 46.2% is cultivated (36% semiarid rain-fed farmland), 33.3% is dry pastures, 20.5% is forest and bush.

One of GAP's major goals is to remove the socioeconomic disparity between the country's more developed regions and the project area. For GAP to reach its targeted and sustainable economic aims, projects in various other sectors also need to be considered and integrated. In this context, the public health consequences of emerging diseases in this setting must be anticipated so that appropriate health education and disease prevention measures can be implemented.

To anticipate changing patterns in disease associated with microclimatic and other environmental changes, knowledge of existing diseases in the region is vital. Since arthropods, reservoir animals, and other intermediate hosts are involved in the transmission of many waterborne parasitic diseases, a clear understanding of the existing species—especially of insect vectors—is equally important.

Historically, occasional cases of malaria have occurred in the region; however, limited records show that this disease is clearly on the rise. Cutaneous leishmaniasis is also endemic and on the rise, but few data are available on the prevalence of the visceral form of the disease. Other common diseases in the region include bacterial and helminthic gastrointestinal infections as well as trachoma.

According to data from the Malaria Division of the Turkish Health Ministry, the reported cases of *Plasmodium vivax* malaria rose from 8,680 in 1990 to 18,676 in 1992 (4). The province of Sanliurfa (population one million in 1990), which is at the heart of the irrigated plains in GAP, has reported that malaria cases increased from 785 in 1990 to 5,125 in 1993. The numbers of cases in the first 9 months of 1994 alone were already significantly higher than those reported in 1993 (S. Aksoy, unpublished data). Although presumably *P. vivax* malaria is most common, cases of *P. falciparum* malaria have also been reported in the country. Three cases of *P. falciparum* malaria were recently documented in Izmir, which is on the Aegean Sea coast of Turkey (4). No cases of drug-resistant malaria have been reported.

Another endemic disease on the rise in the southeastern region is leishmaniasis, transmitted by biting sand flies. In Sanliurfa the number of documented cases of the cutaneous form of this disease has risen from 552 in 1990 to 1,955 in 1993. In the first 9 months of 1994 alone, the number of reported cases was more than 3,000 (S. Aksoy, unpublished data). At Sanliurfa's Diyarbakir Hospital, in 1991, in addition to cases of the cutaneous forms of the disease, there were 80 potential cases of visceral leishmaniasis (kala-azar) in children ages 2 to 10 (5). *Leishmania donovani* is often the causative agent of kala-azar, but both *L. tropica* and *L. infantum* may also be involved (6). As the economic opportunities in the GAP provinces attract populations to the region, visceral leishmaniasis may become a greater threat. The prevalence of the sand-fly species in the region, their habitats, and the future implications of the microclimatic changes for these habitats must be studied to anticipate future disease patterns.

Other prevalent pathogens in the region include *Entamoeba histolytica, Giardia lamblia, and Ascaris lumbricoides.* Of 22,468 stool samples examined in one study, over 90% carried intestinal parasites; in children from infancy to 5 years of age, 60% contained *Giardia intestinalis* (7). In a second study in Diyarbakir involving 4,670 patients (ages <1–65 years), the incidence of protozoan and helminthic infection was approximately 16% (53%, *E. histolytica*; 31%, *G. lamblia*; and 10%, *A. lumbricoides*) (8). In both studies, the incidence of amebiasis was approximately 8% to 9%. In 1989, a survey conducted among 1,001 children in four elementary schools in Sanliurfa found parasites in 88% of the stool samples examined (50% *Ascaris*, 53% *Trichuris trichiura*, 22% *Giardia*, 11% *Entamoeba coli)* (9). Ancylostomiasis, which occurs in the eastern Mediterranean, is a potential danger for the region (10).

The emergence of schistosomiasis, which can quickly reach epidemic proportions in water-related projects unless measures are taken, should not be ignored. A recent study in Sanliurfa has identified *Bulinus truncatus*, the snail vector of *Schistosoma haematobium* in the region (11). Whether other regions in GAP also harbor this species is not known, although there have been reports of these snails in the Nusaybin and Mardin regions (12). A few decades ago, sporadic cases of disease were also reported from southeastern regions (13). As microclimatic changes occur in the GAP area, the presence of these snails and the potential emergence of schistosomiasis should be closely monitored.

The costs of combating epidemic diseases can be very large, whereas the costs of prevention are much lower. Large national projects that anticipate economic benefits may sometimes overlook the distant prospects of disease. Ideally, health planning should be built into a project from its inception for small funds invested for prevalence studies early on can bring high returns later. Earlier dam projects in Senegal, Lake Volta, and Egypt have shown that unless effective measures are taken early, infections can quickly reach epidemic levels (14). The establishment of good surveillance and recording systems is an important first step.

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