

**ENVIRONMENTAL MANAGEMENT PLAN FOR THE IRRIGATION
IMPROVEMENT PROJECT (IIP) - TAJAN SUBPROJECT**

Ramiz Namvargolian¹
Adel Bichara³

G. Ayaz²
Andrew Bond⁴

ABSTRACT

The Irrigation Improvement Project (IIP) is funded jointly by the Government of Iran and the World Bank. The project with an estimated cost of US\$ 312 million started in 1994 and is expected to be completed by end of 2001.

The project implements irrigation improvement measures in about 107,000 hectares in four subproject areas located in northern and southern Iran. Existing irrigation and associated agricultural practices are having environmental impacts on natural and important man made ecosystems both within and downstream of each of the subprojects areas particularly on local and migratory wildlife. A major part of IIP is an Environmental Management Plan (EMP) which includes in part a) strengthening the institutions and training the personnel responsible for addressing long-term environmental issues related to irrigated agriculture, b) establishing agricultural chemicals management program and surface water and groundwater quality monitoring programs, and c) preparing special studies and mitigation plans to address long-term environmental management issues related to the development of irrigated agriculture.

Good progress has been made with respect to the civil engineering works associated with the project, but a number of issues have delayed environmental mitigation activities associated with the project.

¹
Senior Groundwater Engineer, TechLink Environmental Inc., Fort Collins, CO 80526;
ramvar@TechLink.com

²Environmental Specialist, Khazar-Ab Consulting Engineers, Pasdaran Blvd, Sari, Iran.

³
Senior Irrigation Engineer, Middle East and North Africa Region, The World Bank, 1818 H Street, N.W., Washington, DC 20433. Abichara@worldbank.org

⁴
Environmental Specialist, The World Bank, 1818 H Street, N.W., Washington, DC 20433.
Abond@worldbank.org

Special environmental issues of IIP, particularly those associated with the Tajan Subproject and related mitigation actions are presented in this paper. The traditional irrigation in the Tajan subproject area on the Caspian coast of Iran has resulted in the creation of large irrigation water storage ponds locally known as "ab-bandan". Ab-bandans have evolved into complex man-made and man-maintained ecosystems which are highly valuable to local residents and to local and migratory wildlife. A plan of management for the complex ecosystems of Ab-bandans is being developed.

IRRIGATION IMPROVEMENT PROJECT DESCRIPTION

Irrigation receives the largest amount of public agricultural investment in the developing countries. From 1950 through 1993, seven percent of World Bank lending (US\$ 31 billion) has been devoted to irrigation projects (Jones, 1995). About 69 percent of Bank lending has gone to Asia, while the other 31 percent has been split between Africa, the Americas, and Europe. According to Jones (1995), "In the 1950s the Bank approved, on average, one irrigation project a year; in the 1960s, four per year; in the 1970s and in the 1980s, 26; and so far in the 1990s, 15. Average irrigation lending per year was \$37 million in the 1950s, \$343 million in the 1960s, \$1,120 million in the 1970s, \$1,273 million in the 1980s, and \$1,032 million so far in the 1990s."

More than half of the World Bank's recent lending for irrigation projects has been for extensions, rehabilitations, and upgrades of existing systems.

The Irrigation Improvement Project (IIP) with an estimated cost of US\$ 312 million is funded jointly by The World Bank and The Government of Iran (GOI). IIP includes four subprojects and preparation of all subprojects is well advanced and investments will complete and improve existing schemes thus allowing relatively quick returns in comparison with other potential subsectoral investments in irrigation. GOI is promoting a strategy of full cost recovery for operation and maintenance costs and recovery of 40 percent of on-farm development costs. The project serves as a vehicle for a dialogue on technical issues and on areas where the Bank's experience such as prevention of environmental degradation will be used to enhance the governments longer term irrigation improvement and development objectives.

The overall objectives of the project (The World Bank, 1993) are to: (a) enhance water resources management through the rehabilitation and improvement of irrigation and drainage systems in four subprojects; (b) upgrade agricultural research and extension in the four subprojects in order to raise crop output, farm incomes and foreign exchange savings through increased agricultural production; and (c) improve the planning and implementation capacity of sector institutions,

including the Ministries of Agriculture, Energy, and the Department of Environment.

Location, Climate and Soils

The project with a total area of 107,000 ha and is composed of four subproject areas (Figure 1): Behbahan (11,500 ha), Moghan (35,600 ha), Zarrineh Roud (36,000 ha), and Tajan (23,900 ha). Climatic conditions in the subproject areas vary from semi-arid in the first three subprojects with average annual rainfalls of about 300 mm to sub-humid in Tajan with an average annual rainfall of 650 mm. Soils in the four areas are of alluvial origin and are deep with textures varying from silty loams to clay loams. Moderate to insignificant slopes in each of the subproject areas has led to poor drainage, and improved water management, drainage and land leveling activities are supported by the project..

Land and Farming

Before the project, 77 percent of the project area was irrigated, 16 percent was rainfed and the remaining 7 percent was marginal land used for grazing or left uncultivated, mainly due to salinity and drought problems. In general, land in the subproject areas is privately owned and farmed. Plots are small and land fragmentation is a problem in some areas. Farmers generally cooperate in traditional groups which are valuable asset to the project. Agricultural research and extension centers are present at each of the subprojects and Tajan also benefits from an additional research center dedicated to research on rice. Levels of mechanization differ in each subproject and depends largely on farm size. Farm operations are almost totally mechanized at Moghan subproject. In the other subprojects, land preparation is generally by tractor or on the small farms by power tiller. The most common fertilizer in the project area is urea followed by diammonium phosphate. Potassium sulphate and triple super phosphate are used in smaller quantities. Pesticide use is widespread with extension services providing training in pesticide use and safety.

The agricultural research stations and service centers are being strengthened through the upgrading of existing staff and through the construction of facilities and the provision of additional staff, vehicles and specialized equipment. Specialized farm machinery would be made available. Strengthening the operation and maintenance of all facilities starting from the main to the tertiary system, developing farmer participation through users groups, and addressing critical environmental issues are being emphasized. The project has provided various training and education programs.

Irrigation and Drainage Systems

The existing traditional irrigation systems or partially completed modern ones are highly inefficient in using the scarce water resources. Maintenance of irrigation and drainage networks needs major improvement. Inadequate water conveyance and inefficient on-farm water use have reduced the overall irrigation efficiency to 20 to 30 percent. As a result, there is not enough water to extend the presently irrigated area or to increase yields in the existing areas. Additionally, water logging problems in the low lands reduce crop yields and keep significant areas permanently or intermittently uncultivated. All four subproject areas receive their primary supply from existing or future water management infrastructure and based on available river flows it is expected that irrigation requirements be met at all times of the year. A planned overall irrigation efficiency of 50 percent is anticipated under the project.

The irrigation and drainage improvement section of the project includes the construction or lining of main, secondary, and tertiary canals and drains. The details of irrigation and drainage works are presented in Table 1. The project consists of the improvement and upgrading of four existing irrigation and drainage systems, serving a total of net irrigable area of about 90,600 ha and the intensification of agricultural services on these 90,600 ha and on an additional 16,400 ha in Tajan subproject area. Existing main and secondary canals are provided with concrete lining and in some areas new canals are being added. Main and secondary drains are being improved and expanded to cover all the subproject areas. The tertiary systems are being developed selectively using canalletes, concrete lined or unlined laterals, and open drains. Selective land leveling and subsurface drainage with the emphasis on water management at the tertiary and farm levels are included in the on farm development section of the project.

Environment

The environment component of IIP consists of: (i) the strengthening of the environmental management capacity of Ministries of Agriculture and Energy and Department of Environment and their provincial offices through specialized training programs and the provision of equipment; (ii) the development of agricultural chemical management programs (including integrated pest management) and model surface and groundwater monitoring programs for each subproject; (iii) erosion control programs for canal banks in Moghan and river channels in Tajan, (iv) an archaeological site survey in Behbahan; (v) special environmental management studies of the Shadegan Marshes Protected Area in Behbahan subproject area, Lake Orumiyeh National Park in Zarrineh Roud subproject area, "ab-bandan" man-made ecosystems in the Tajan subproject area; and (vi) fishery resources of Behbahan and Tajan subprojects.

Table 1 - Irrigation and Drainage Works and On-Farm Development by Subproject (World Bank, 1993).

Behbahan	Subsurface drainage on 3,300 ha; land leveling on 8,000 ha; and soil amendment on 1,700 ha.
Moghan	Concrete lining (17.5 km) and slope stabilization (60 km) on the main canal; concrete lining on secondary canals (21,000 ha); the construction of tertiary canals and drains (27,400 ha); a pumping station for the reuse of drainage return flows; subsurface drainage (11,000 ha); and land leveling (4,500 ha).
Zarrineh Roud	Concrete lining of the main canals (97 km); the extension and lining of the left main canal (17 km); construction of the lined secondary canals and surface drains (24,800 ha); a tertiary irrigation and drainage system (36,000 ha); subsurface drainage (7,500 ha); land leveling (4,500 ha); and two irrigation lift stations and one drainage pumping station.
Tajan	The construction of the lined main canal (35 km), the main drain (22 km), and secondary and tertiary canals and drains (7,500 ha).

TAJAN SUBPROJECT

Water Resources Development

The Irrigation Improvement Project is part of several large water resources development projects in Iran. In the Tajan subproject area the water resources project, extending from the Caspian Sea in the north to the Alborz Mountains in the south, includes watershed management, a storage dam, a diversion dam, irrigation development, urban and industrial water supply, electricity generation. The upper reaches of the Tajan is regulated by the storage dam and a watershed management plan for the area above the storage dam is under development. The construction of the reservoir dam has been completed recently. It is a 133 m high double curved concrete dam built on Tajan River about 40 km south of city of Sari (Figure 2). Its reservoir can hold up to 192 million cubic meters and can cause a regulated flow of 316 million cubic meters in the Tajan River. The diversion dam was built in 1995 for regulating Tajan River flow to the Tajan plain farm lands. It is located in Sari and has a length of 264 m and 18 outlet gates (Figure 2). The irrigation network consists of two main canals that extend to left and right sides of the Tajan River. Several subsidiary canals branch off these two main canals and extend to the farm lands.

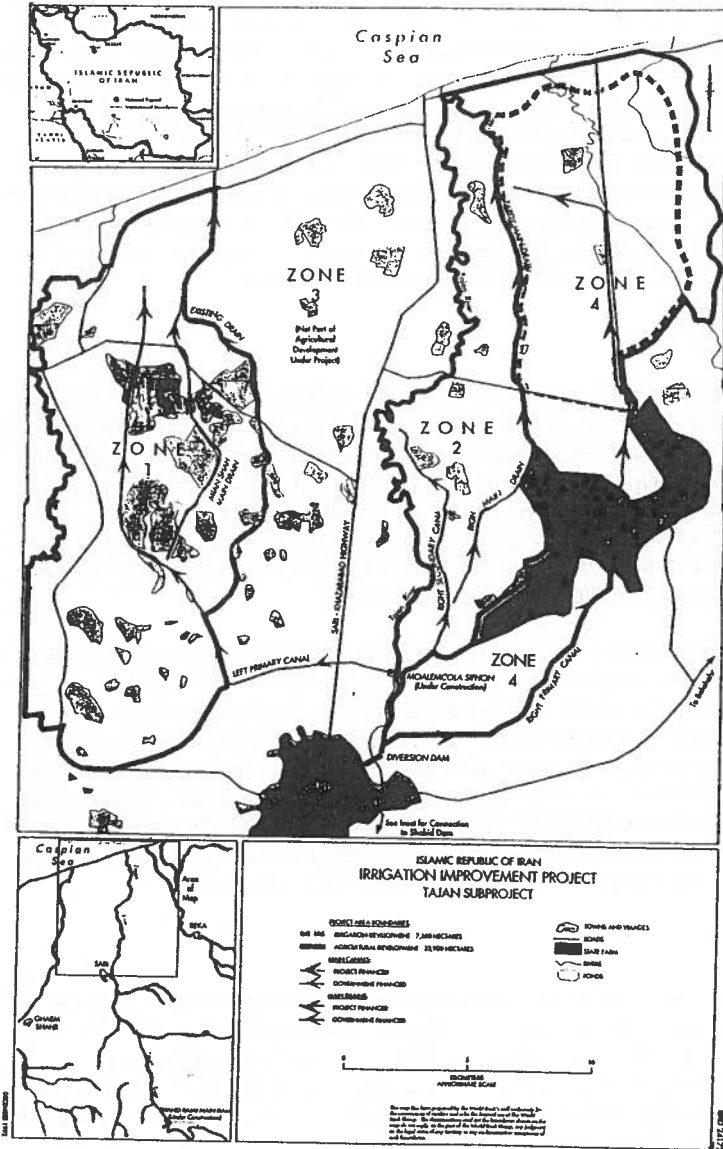


Figure 2 – Tajan Subproject.

The water resources project of Tajan is located in the eastern and western banks of Tajan River in an area of about 3500 square km in two upper and lower sections. The upper section, south of the provincial railway, is part of the Tajan basin on the northern slopes of the Alborz Mountains and extends from the reservoir dam to the city of Sari. This section with an area of about 2750 square km is the middle Tajan River basin and encompasses the eastern and western banks of the Tajan River. The middle Tajan River basin includes vast irrigated farming, main part of dry farming, major river sand and gravel exploitation, and pulp and paper and dairy industries. The lower section with an area of about 700 square km extends from the City of Sari to the Caspian Sea. The Ab-bandan ecosystems are located in the lower section on the left and right banks of the Tajan River.

Ab-bandans

Most of the irrigated farm lands are on the left bank and the rainfed lands are mostly on the right bank of Tajan River. Accordingly, the left bank of Tajan River with an area of about 40,000 hectares contains 78 Ab-bandans, and the right bank with an area of about 30,000 hectares contains 31 Ab-bandans. The Ab-bandans in the left and right banks cover about 3515 and 800 hectares, respectively. Ab-bandans have been developed mostly on lands with no direct water rights to Tajan River. More than 340,000 migratory birds come annually to Ab-bandans of Tajan plain for feeding, breeding, wintering, and nesting.

There are 649 pieces of developed Ab-bandans, with a total pond area of about 15,000 hectares, in the western and central regions of the province of Mazandaran, in the southern shores of Caspian Sea. Tajan plain contains 109 pieces of these Ab-bandans and they cover an area of about 4,300 hectares and annually reserve about 65 million cubic meters of water. Ab-bandans vary in size, with the smallest and largest in Tajan area having surface areas of 1 ha and 382 ha, respectively (Khazar-Ab, 1997). While Tajan River provides the largest quantity of water to the Ab-bandans, rainfall, irrigation return flows or drainage water, and two nearby rivers contribute to the water stored in the Ab-bandans.

Tajan River

In addition to being the most important source of agricultural water of the area, the Tajan River is the best habitat of migratory fish including sturgeons. The river originates in the Alborz mountains and after a flowing through 170 km of mountainous and flat areas terminates in Caspian Sea. Tajan River with an annual flow of 527 million cubic meter and water quality class of C2S1 is one of the most important habitats of various endemic and migratory fish among more than 90 rivers of Mazandaran province in southeastern coast of Caspian Sea.

The city of Sari, which does not have a municipal wastewater collection and treatment system, is immediately upstream of the diversion dam. Additionally, more than 20 nearby villages discharge their untreated wastewater to the Tajan River. Wastewater from a thermal mechanical paper plant and a milk plant is discharged up gradient from the diversion dam. Water quality of the Tajan River is also affected by cultivation to the edge of the river and sand and gravel extraction operations.

Impacts of the Irrigation Improvement Project - Tajan Subproject

The implementation of the Irrigation Improvement Project in Tajan region was expected to have the following positive impacts:

- (i) improved management of irrigated agriculture in a region with extensive irrigated agriculture,
- (ii) improved water use efficiency, and
- (iii) improved drainage with a reduction in water logging and salinization risk in an extensive portion of the subproject area.

It was anticipated that the project may increase the potential for some negative impacts if mitigation measures were not included as integral project activities. Converting 7,500 hectares of rainfed agricultural land to an irrigated agricultural system without improvement in the existing management of agricultural chemicals would result in adverse environmental impacts. The project accomplishment may be influenced by the adverse impacts resulting from the periodic contamination of the irrigation water supply by the upstream discharge of wastewater and excessive sedimentation behind the diversion dam and in the canal system by sediment generated in the mid-Tajan River Basin which are beyond the scope of the project. Risk of prevention of passage of migratory fish through the diversion dam and its fish ladder and outlet gates; and entrance of migratory fish into the irrigation canal system constitute another possible adverse impact. Also the invaluable Ab-bandans may be developed into farmlands or their surface area may be decreased subsequent to the installation of the irrigation system.

Several mitigation actions are undertaken to reduce the adverse impacts of the project and the risks that may negatively influence the project achievements. The mitigation actions include: (i) an Agricultural Chemical Management Program, (ii) a Water Quality Monitoring Program with emphasis on the monitoring of upstream wastewater discharges and discharges from the drains to marine environment, and (iii) a management program for the Middle Tajan River Basin to establish a river zoning system to support land use decisions, development of a riverside "set-back" system to reduce bank erosion, pilot riverside afforestation program, and an evaluation of actions which can be taken to reduce excessive sediment generation and stream bank damage from the extensive sand and gravel excavation and washing operations.

ENVIRONMENTAL MANAGEMENT PLAN ACTIVITIES IN TAJAN

The Environmental Management Plan in Tajan includes implementation of (i) surface and groundwater quality monitoring, (ii) strengthening of institutional and personnel capacities for addressing environmental issues of the project, and (iii) development of an agricultural chemicals management program.

The project supports many institutional and personnel strengthening activities concerned with environmental management issues at the national and subproject levels. Training of personnel was to be conducted through international training, in-country training, and "train the trainer" programs. The project has provision for training for personnel from the Department of Environment at subproject level in environmental management, preparation of environmental assessment, environmental monitoring and in the development of work plans. The project also provides office equipment, computers, reference materials, vehicles, and support for the construction of field facilities

In Tajan two special studies are focused on addressing long-term environmental management issues related to the development of irrigated agriculture. These studies include:

- (a) Management Plan for the man-made "Ab-Bandan" Ecosystems, and
- (b) Tajan River Migratory Fish Management Plan.

Surface Water and Groundwater Quality Monitoring Programs

Improved water quality and quantity management is being implemented to improve the present water use which has an efficiency of 30% and results in wastage of water, water logging and salinization. The water management issues are addressed through increased user fees for water to promote conservation and efficient use, rehabilitation of irrigation and drainage systems to provide water in a timely manner and reduce seepage from canals, improving the capacity of farmers for efficient water management through on-farm programs. A surface and groundwater monitoring program has been developed for collection, analysis and interpretation of data to support the operation of the irrigation system, protection of domestic water supplies, and the conservation of natural habitats, fish and wildlife populations. The development of monitoring program is being coordinated with on-going water quality data collection programs.

Local authorities routinely monitor surface and groundwater quality by collecting information on parameters related to water quality requirements for irrigated agriculture (cations and anions) and bacteriological and chemical aspects of water quality related to the safety of drinking water supplies. Prior to the project, however, there was no program for collection, analysis, and use of water quality monitoring data for the management of this irrigation project. Water quality in Tajan area is

variable with better quality obtained during irrigation season and lower quality occurring following the irrigation period. The quality of surface water is effected by fertilizers which along with low flows and inadequate channel maintenance practices results in growth of algae and reeds in the systems. Transport of fertilizers and pesticides into the local aquifer, drainage from farm lands, and seepage in the canals greatly influence groundwater quality. Monitoring of several significant parameters at representative locations such as key points within irrigation and drainage network, major domestic water supply intakes, and municipal and industrial wastewater discharge points has been included in the surface/groundwater monitoring programs.

Agricultural Chemicals Management Programs

Agricultural chemicals, including fertilizers and pesticides, due to their subsidized low price are not utilized appropriately. Private farmers and state farms may use up to twice the recommended amounts of pesticides and fertilizers. The extent of negative impact of these practices on surface water, groundwater, soil quality, human health, and wildlife is not known. An agricultural chemical management program has been developed for improved management and reduced use of chemicals. The program is supporting application of alternative means of crop fertilization and crop protection including integrated pest management.

Migratory Fish Management Plan for Tajan River

A management plan has been prepared and will be implemented to revitalize the fishery resources of the Tajan River following completion of the diversion dam which includes a fish ladder and the establishment of a backwater pond of a sufficient depth to allow migratory fish to go upstream of the diversion dam. This management plan includes the development of information concerning anadromous and catadromous fishes traditionally found in the river including caviar sturgeon and trout; an ecological analysis of the Tajan River and monitoring of the fish ladder particularly during periods of low flow and migration. Support is being provided for strengthening the monitoring program of the Fisheries Research Center of the province through staff training, consultancy support, and procurement of specialized equipment.

Development of Management Plan for the Man-Made Ab-bandans Ecosystems

As a result of the traditional spate irrigation practices in the irrigated areas of the Caspian coast of Iran and in particular in the Tajan subproject many large irrigation water storage ponds have been constructed. These storage ponds are locally known as "Ab-bandan" or water holders. Over the years, Ab-bandans have evolved into complex man-made and man-maintained ecosystems with a high economic value to local residents and as a habitat for local and migratory wildlife, specially waterfowl. Ab-bandans are important for irrigation water control,

production of fish, hunting of birds, rental to the local Department of Environment for bird protection, harvesting of reeds, and recreational use. These ecosystems are collectively owned and managed by groups of families, with sometimes over 250 families involved. It is a complex task to manage the dynamic and important ecosystems of Ab-bandans.

A special study is supported by the IIP project to develop practical approach for the management of the Ab-bandans by their collective owners with the support of the local Department of Environment. The Ab-bandan management plan includes: an inventory of the ab-bandans with information on their size, physical status, irrigated command areas and ownership; a detailed inventory of the birds wintering on the Ab-bandans; development of topology and mapping of Ab-bandans in regard to their ecological roles and conditions, type of bird feeding grounds, and socioeconomic uses by farmers; and evaluation of costs of different management options. In coordination with local government offices, the Department of Environment will implement the management plan by reaching agreements with the owners of Ab-bandans for their rental and monitoring their use by birds and their modifications as part of their management.

PROGRESS TO DATE - TAJAN ENVIRONMENTAL MANAGEMENT

The project due for completion by the end of 2001 was initially beset by a number of delays which have affected nearly all aspects of the project. With respect to the projects civil works, in the main these have recovered and are now proceeding well although attention to the on-going needs for operation and maintenance of the works, critical for the longevity of the project objectives, is only beginning to be the focus of project management.

The reasons for these initial delays are complex. World Bank operations in Iran have been limited and experience in the implementation of complex projects in a partnership with the Bank and GOI was not well established at the outset of the project. This was evidenced for example by delays in basic procurement procedures including the provision of necessary budget resources in a timely manner consistent with the project schedule, delays in consultant selection and tendering and to some extent were all result of differing requirements of the Bank and the GOI. These issues took time to resolve. The project management designed for the project, involving the establishment of two Liaison Offices for the two sectoral Ministries (Agriculture and Energy) has ultimately been successful but in the light of project experience should be reexamined for future activities.

With respect to the environmental activities a complex set of factors has emerged. Technical issues within the Iranian institutional context took time to resolve. These included acceptance of Terms of Reference for the relevant studies and dealing

with a limited private environmental consulting sector in Iran. The sectoral Ministries, more accustomed to the delivery of high quality mainstream engineering and agricultural development activities, took time to absorb the project objectives with respect to relatively innovative environmental management practice.

Albeit late in the project, most environmental aspects with respect to Tajan are producing or are likely to produce impacts on the ground and a legacy for the future. To date it is premature to attempt to quantify these impacts, but a number of outcomes can be indicated at this stage. These include:

- (a) institutionalisation of surface and ground water and agriculture chemical monitoring programs with the possible establishment of an inter-ministerial committee on residues, norms and monitoring
- (b) at least in the pilot areas, increased environmental awareness, health and safety issues pertinent to agrochemical usage enforced by clear demonstrations of increased yields while decreasing chemical usage with biological control
- (c) completion of the Tajan Ab-bandan and Middle River Basin studies which will likely result in considerable implementation activities in the next 18 months. As such a number of ab-bandans will be afforded management with a primary focus for conservation alone, while others will maximize opportunities for sustainable use with the benefits directly flowing to the traditional owners. The Middle River Basin studies, in terms of implementation, are more complex. Priority programs such as afforestation and development set backs will only be initiated in the remaining project period.

REFERENCES

1. Khazar-Ab Consulting Engineers, 1997. Natural aquatic ecosystems of Tajan. Project Report, Khazar-Ab Consulting Engineers. Sari, Iran.
2. Jones, William, J. 1995. The World Bank and Irrigation - A World Bank Operations Evaluation Study. The World Bank, Washington DC, USA.
3. The World Bank, 1993. Irrigation Improvement Project - Staff Appraisal Report. The World Bank, Washington DC.