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Inter-Basin Water Transfers: Feasibility Analysis and Ethical Assessment

G. Rossi
Department of Civil and Environmental Engineering
University of Catania, Catania - 95125, ITALY
E-mail: grossi@dica.unict.it

ABSTRACT: Since the ancient civilizations, Inter-Basin Water Transfers (IBWT) have been implemented to supply urban areas and/or irrigated districts lacking of adequate local water resources. As a consequence of growing water demands for municipal, tourist, agricultural and industrial uses, large-scale inter-basin water transfers have been proposed to implement integrated water planning in several countries. However, the increased public awareness on ecosystems protection and sustainable development often leads to environmental and political controversies or conflicts which delay or even stop the process of implementing the proposed IBWT.

This paper presents a conceptual framework aimed to facilitate an objective decision on the choice of an IBWT also with respect to other supply alternatives. Such a framework includes a list of hydrological, economical and environmental criteria derived from some general principles of social and environmental ethics. In particular, the specific principles are: (i) inter basin solidarity aimed to supply uses with higher priority established on the basis of human rights and equity, independently of their location, (ii) subsidiarity among different levels of government, able to resolute possible disputes and founded on public participation to the decision process; (iii) sustainable development for both basins based on inter-generation equity, (iv) minimization of impacts on environment and ecosystems founded on an anthropocentric ethical option enlarged to consider also a biocentric point of view.

INTRODUCTION

An Inter-Basin Water Transfer (IBWT) is basically a transfer of water from a river basin (exporting or donor basin) into another one (recipient basin) by means a conveyance conduit (canal or pipe) realized to satisfy water needs in the receiving basin which cannot be adequately met by available water resources. A water transfer infrastructure presents a greater complexity with respect to an aqueduct, even of comparable size, built in the same river basin where the uses are located, not only for technical (hydrological and hydraulic) reasons, but also for the consequent environmental, political and social issues it implies.

A large literature exists on different aspects of water transfers, oriented to analyse the evolution of the infrastructures (Shiklomanov, 1985 and 1999), to discuss the impacts on third parties (CWWM, 1999) or on environment and society (Arrojo, 2003), to investigate the type of controversies and/or conflicts by proposing criteria and methods to facilitate the decision process (Unesco, 1999; Yevjevich, 2001; Chander, 2003; Jain *et al.*, 2005; Castelo de Carvalho and Magrini, 2006).

The aim of this paper is to contribute to derive a list of criteria to be adopted for a comprehensive feasibility analysis, including hydrological, economic, environmental and public participation issues, based on some general principles related to both social and environmental ethics.

WATER TRANSFERS: EVOLUTION AND CONTROVERSIES

Inter-basin water transfers have a long history dating back thousands of years. They have been built to satisfy drinking water needs of highly populated urban areas and/or to support irrigated agriculture in arid or semi-arid basins, unable to satisfy water requirements with local available surface or groundwater resources. Ancient municipal aqueducts in different parts of the Roman Empire, as well as big canals for irrigation in Mesopotamia, Egypt and China, are examples of these transfers from adjacent basins with a relative more abundance of water, generally consisting of diversions from rivers or perennial springs and canals and tunnels for gravity transport to supply specific use (see Figure 1).

As a consequence of growing water demands for municipal and agricultural uses, large-scale water transfers have been planned and developed all over the world since the twentieth century with complex layouts including canals and tunnels, pumping plants, regulation reservoirs and often multi-purpose supply (e.g. in United States, Italy, Russia, Spain, etc.). For instance, in the early decades of the past century, a large scale water transfer (Apulian Aqueduct) has been developed in Italy to satisfy municipal water needs of Apulia region transferring spring water from the more water-rich region Campania (see Figure 2).

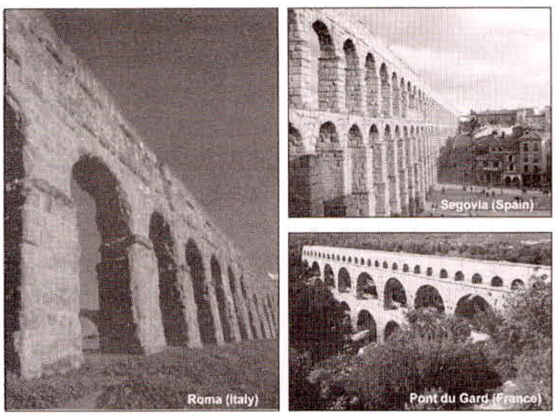

Fig. 1: Ancient Roman aqueducts

Until the 80's of the past century, under the pressure of the increasing water consumption and deterioration of natural water quality, as well as of the uneven distribution in space of water resources, water transfers have been considered as one of the most promising solution to the supply problems of areas where urban growth, tourist development and irrigation expansion were limited by water scarcity (Shiklomanov, 1985). With the increasing frequency of severe drought occurrence water transfers have been also proposed as a facility to cover temporary deficit of recipient basin in drought years or as bilateral exchange of resources between basins characterized by a not homogeneous inter-annual variability. Large water transfer schemes represented a significant part of water resources planning which was developed both in the West countries and in the communist countries, in spite of the different political regimes. A study on main transfers developed from the beginning of the twentieth century and planned for the first decades of the twenty-first century (Table 1) evaluated that the transferred volumes would have increased from 22 billions of m^3/year to 360 billions on 1986, with an expected volume ranging between 760 and 1240 billion of m^3 for the period 2000–2020.

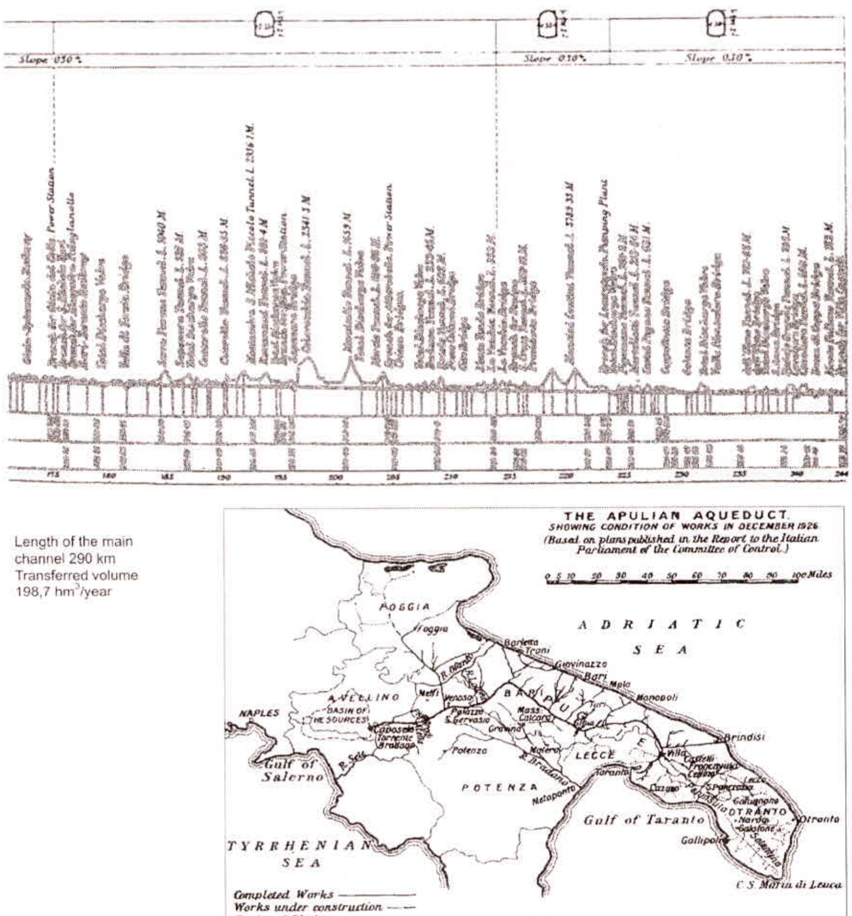

Fig. 2: Profile and map of the Apulian Aqueduct

Table 1: Past Growth of the Volumes of Water Transfers and Forecasted Amounts in Different Countries (from Shiklomanov, 1999)

Year / *Country*	Transferred Volumes [km^3/year]								
	1900	*1920*	*1940*	*1960*	*1970*	*1980*	*1986*	*2000–2020*	
								min	*max*
Canada	7	7	10	14	25	90	140	260	300
USA	–	2	20	26	27	27	30	150	250
Mexico	–	–	–	1	4	4	9	10	15
Ex URSS	–	8	8	10	25	47	60	100	220
Netherlands	–	–	–	–	–	2	5	15	20
India	15	15	18	18	2	37	50	130	310
China	–	–	–	40	45	50	10	30	40
Other	–	–	–	–	–	–	60	65	80
Total	22	24	56	109	148	257	364	760	1240

In the last decades, these forecasted amounts were not confirmed. Indeed, public awareness on protection of aquatic ecosystems and on conservation of resources for potential future needs in the exporting basin, has led to several environmental and political controversies. These controversies arise generally between the water users of the exporting basin, who are afraid of loosing future benefits and the water users of the receiving basin who expect to obtain benefits from new diverted resources. Furthermore, third parties (i.e. population, ethnic and environmental groups different from direct users interested by the transfer in the two basins), which can be potentially affected by the negative impacts of water transfers can be source of conflicts (see CWWM, 1992).

As a result of such conflicts, in some countries (e.g. USA, Spain) the implementation of some of the planned transfers has been halted because of environmental and/or political reasons. A recent example is the water transfer from Ebro river to Segura, Jucar and Sur basins and Cataluna region in Spain, which was cancelled on 2004, despite the project had already passed the design and environmental assessment stages. This water transfer had been proposed in a general scheme by the National Plan of 1967 aimed to cover the water shortage of Southern Spain through three IBWTs. (see Figure 3). The transfer was also included in the National Hydrological Plan (2000), after the positive experience of the Tajo-Segura water transfer already in operation and the detailed design had already passed the environmental impact assessment (see Figure 4). However, the change of government Party after the elections of 2004 led to the decision of stopping the water transfer, which has been subject to a large debate in Spain involving also several foreign experts, and of covering partially water shortages of eastern cost of Spain though alternative solutions such as demand management and use of treated wastewaters and desalinated waters, which appeared preferable since they would avoid environmental impacts on Ebro delta and coastal ecosystems and would be cheaper (Arrojo, 2003).

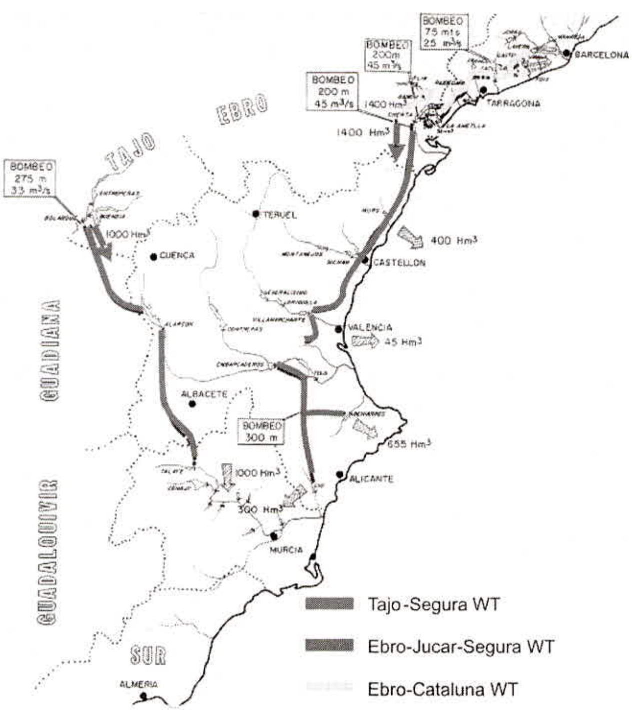

Fig. 3: Water transfers planned in Spain on 1967 (from MIMAM, 2000)

Nonetheless, very large water transfers continue to be proposed in many countries, particularly in Asia and South America. For example in China, beside the

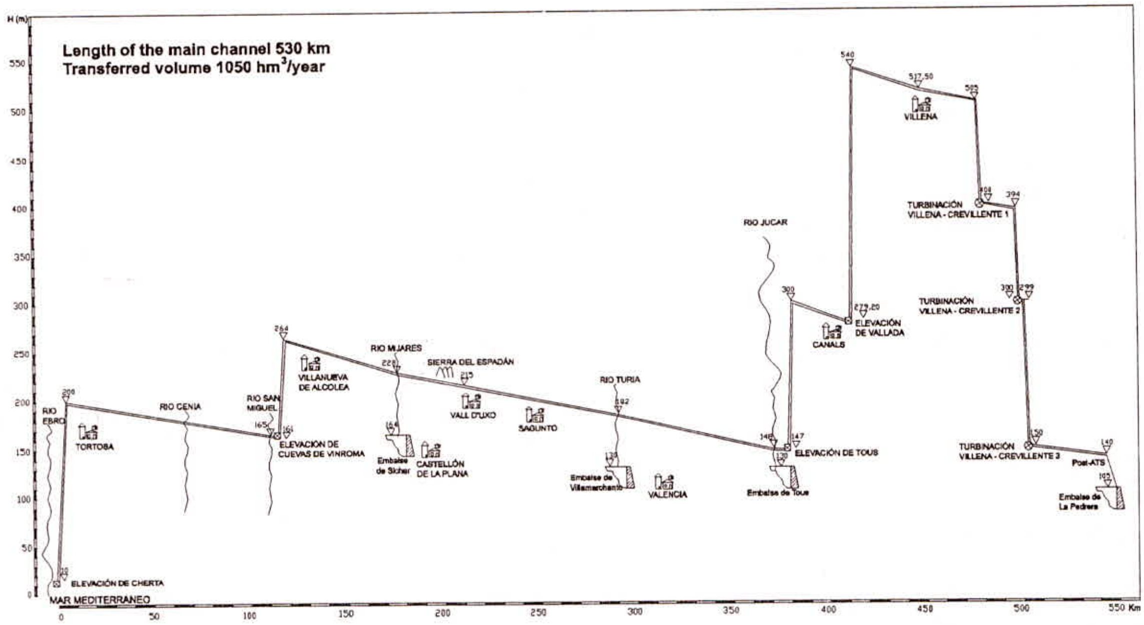

Fig. 4: Profile of proposed water transfer from Ebro (from MIMAM, 2000)

Table 2: Main Characteristics of the South-to-North Water Transfer in China

IBWT	*Exporting River*	*Recipient River*	*Length (km)*	*Diverted Volume (km^3/yr)*	*Reservoirs No.*	*Pumping Station No.*	*Irrigated Area (10^6 hm^2)*
East Route	Yangtze	Yellow	1150	150	10	23	2.26
Middle Route	Yangtze	Huaihe, Haihe	1240	130	40	0	2.32
West Route	Yangtze	Yellow	700	170	7	10	2.33

water transfers already in operation, a very big South-to-North IBWT has been planned (Shao *et al.*, 2003), including three main schemes conventionally indicated as East Route, Middle Route and West Route, which present exceptional dimensions both for planned diverted volume and length of transfer (see Table 2).

In India, two components of the National Plan for water resources development include complex IBWT within Himalayan Rivers Development and Peninsular Rivers Development (Jain *et al.*, 2005). Among the countries in South America, Brazil has developed some proposals of water transfers, which however find difficulties to be implemented due also to the fact that the new Law issued on 2000, for reorganizing water resources management, does not include specific provisions for transfers from a basin to another (Castelo de Carvalho and Magrini, 2006).

MAIN ISSUES FOR IDENTIFYING SHARED CRITERIA TO JUSTIFY WATER TRANSFERS

In general terms, according to the paradigm prevailing in societies or countries involved in the IBWT, a water transfer project could be considered as: (i) an enterprise of selling and buying water between two partners or (ii) a solidarity tool between two basins which accept to overcome their shortage and surplus conditions by sharing common resources, or (iii) a joint venture for the best utilization of water resources of neighbouring territories, considered as a single unit safeguarding the rights of future generations and ecosystem's life, particularly in the exporting basin.

Past experiences of existing water transfers, even when they can be considered successful (with benefits greater than costs and limited opposition from the exporting basin population), do not represent an adequate basis for solving controversies or conflicts arising on new projects, due to: (i) increased environmental sensitivity which tends to give preference to the protection of ecosystems on economic growth, (ii) the tendency of the population of the exporting basin to defend their own water resources either for potential future developments or, in particular cases, to protect regional heritage and cultural value of river's water.

Also the approaches that have been followed in some cases for conflicts resolution did not prove successful to reach a shared decision. Indeed, the possibility of judicial opposition to government decisions, which is guaranteed in a democratic regime, generally leads to long delays and to a potential increase of political animosity between the involved parties. Furthermore, an agreement based on the compensation of the present and future losses of exporting basin through direct negotiations, does not always assure equity of solution due to the different strength of the parties. On the other hand, arbitration, which has also been proposed to solve transboundary freshwater disputes, require that all the parties in conflict accept the procedure which may be difficult to obtain in absence of a consolidated legal framework.

From the above, it follows that the possibility to reach a mutually acceptable decision on an IBWT, that minimizes the controversies and conflicts and reduces the subjectivity of the political choice requires the establishment of a set of criteria derived from general ethical principles and oriented to verify the technical and economic feasibility and environmental and social sustainability of the proposal through an objective procedure. In particular, it appears that the following main issues must be addressed:

1. *Hydrological Feasibility*
   - What criteria must be adopted to estimate the available water resources in the exporting and recipient basin? Should only water surface resources be considered or all resources including groundwater and non-conventional resources as well? If a negative trend has been detected in the hydrological time series, how to deal with non stationarity, also with reference to the potential impacts of climate change?
   - What criteria should be adopted to estimate future water demands of various sectors in the recipient and exporting basins? Do the same minimum supply levels have to be adopted for a specific use in the two basins? How to take properly into account scenarios of demand modifications due to technological innovations and/or changes in the behaviours of water users?
   - What procedure have to be adopted for computing permanent water deficit or temporary shortage in recipient basin? What procedure must be considered to compute surplus conditions in the basin of origin? Can a water balance between water demands at certain fixed time-horizons and water availability corresponding to selected probabilities be considered sufficient? In what cases should a detailed simulation of the water supply systems be carried out in order to compute the deficit and surplus conditions over a long time series and to assess the improvements of the performance of the whole complex supply system due to the implementation of the IBWT?
2. *Economic Feasibility*
   - What methodology has to be adopted for economic feasibility analysis? Is the consolidated cost-benefit analysis technique generally used to analyse feasibility of large infrastructures also adequate for the IBWT case? How to compute costs and benefits? Is it necessary to include in the list of costs (beside investments, operation, maintenance and replacement) also compensation to the production losses and to intangible damages to people of the basin of origin?
3. *Environmental Impact Assessment*
   - What is the scope of environmental assessment, which represent a key factor for acceptance of transfer? What are the basic elements that environmental impact assessment should take into account in order to be used to compare water transfer with other strategic solutions to water scarcity problems in recipient basin and/or to define the preferable route of transfer?

Due to the particular nature of the problem, it appears that definition of shared criteria among the involved parties may not be a simple task and therefore, in order to facilitate the acceptance of such criteria, they should be based on a few general ethical principles shared by all the parties. In particular, shared ethical principles should stem from the answers to the following questions:

Which ethical option (between the prevailing anthropocentric or biocentric approaches) should constitute the basis to derive the specific ethical principles which should guide the decision process on water transfer? What ethical arguments constitute the ground for justifying the water requests from the receiving basin? What ethical arguments could be invoked to accept or not the water transfer by the exporting basin? In particular what are the water needs that have to be satisfied with higher priority among different uses and different basins?

ETHICAL PERSPECTIVES OF WATER TRANSFERS

In spite of several proposals elaborated in recent years (Selborne, 2000; Petrella, 2001; FNCA, 2005), a set of consolidated specific ethical principles on water resources management is still lacking. Nonetheless, some indications can be drawn from the international laws developed in the last decades on this topic, especially for despute resolution in transboundary water resources management (Ganoulis *et al.*, 1994). Within this framework, a particular attention has to be paid to the principles of the "UN Convention on the Law of the non-navigational uses of the international watercourses" (United Nations, 1997), that was modelled on the Helsinki Rules (1966) of the International Law Association (ILA), and that, although ratified only by 16 States, represents an authoritative guide for international agreements. Although the Convention deals with the problem of water allocation in vague terms yet, it establishes that the States "in their respective territories utilize an international watercourse in an equitable and reasonable manner" (art. 5) and that "they take all appropriate measures to prevent significant harms to other watercourse States" (art. 7), but does not set a clear priority between the two principles. Thus, this formulation does not solve the dispute between upstream riparian part (that emphasize the principle of equitable utilization for justifying their "water rights" based on the *doctrine of absolute sovereign*, limiting the river flow downstream) and downstream riparian part that focus on "no significant harm" for advocating the *"historic rights principle*" in protecting their own pre-existing uses (see Beach *et al.*, 2000).

Also the Convention does not provide a clear guidelines for a hierarchy of the different uses, as art. 10 states that both "in absence of agreement no use enjoy inherent priority over other uses" and "in the event of a conflict between uses… a special regard (has to be given) to the requirements of vital human needs".

More advanced indications can be found in "The Berlin Rules on Water resources", issued by the International Law Association (2004), that apply to the management of all waters (not only to international shared waters) and that enlarge the principles of UN Convention on equitable utilization and avoidance of trans-boundary harm as well as on cooperation on the parties, by adopting the following five principles:

1. Conjunctive water management (arts. 5, 37),
2. Integrated water management (arts. 6, 22–24, 37–41),
3. Partecipatory management (arts. 4, 17–21, 30, 69–71),
4. Sustainability (arts. 7, 10(1), 12(2) 13(2), 22, 23, 29, 35(2), 38, 40, 54(1), 58(3), 62, 64(1) and
5. Minimization of environmental harm (arts. 8, 13(2), 22.35; 38–41).

Besides, the Berlin Rules enlarge also the duties of the States already established by the Convention (i.e. right of utilization of water and obligation of cooperation for a sustainable development), since it establishes that the States have to provide legal tools, administrative institutions and court procedures to achieve the purposes indicated by Rules, by developing education and research programmes aimed to guarantee technical capacity.

The importance of the Berlin Rules is that it merges, in a single legal instrument, principles developed within the technical approaches to water resources management (such as the conjunctive use and integrated management) and ethical principles based on human rights and environmental concerns (such as sustainability, environmental protection and participation of stakeholders to decision).

Although the above cited legal instruments can provide useful indications, here an attempt is made to derive specific ethical principles, able to orientate the final decision on the water transfers, from more general principles of social and environmental ethics.

In Figure 5 the relationship between the general principles of social and environmental ethics and the proposed specific ethical principles for IBWT, are indicated.

With reference to an enlarged view of social ethic (aimed to achieve justice and common good, considered as basic values), two principles seem to be pertinent to water resources problems: *solidarity principle*, not only in individual terms but institutional as well (see Rawls, 1986), and *subsidiarity principle* (justifying the intervention of a higher community to help the minor community to solve the own problems), under the hypothesis that public participation is guarantee at different levels. With reference to environmental ethics an enlarged option that try to overcome the debate between anthropocentric and biocentric approaches, is based on a joint view that attempts to revise the traditional anthropocentric view, in order to avoid negative consequences of the concept of the man ruling over (or dominating) all creation at his exclusive advantage and to explicitly recognize the intrinsic value of nature, beside the rights of future generations (see Jonas, 1984). From such a view (indicated by Rosenberger, 2006) as "anthropo-bio-theo-logal ethic" in order to underline the comprehensive characteristic of the approach), the focus can be given to *sustainable development principle* based on intergeneration equity (required also by social ethic) and to *ecosystem protection principle*.

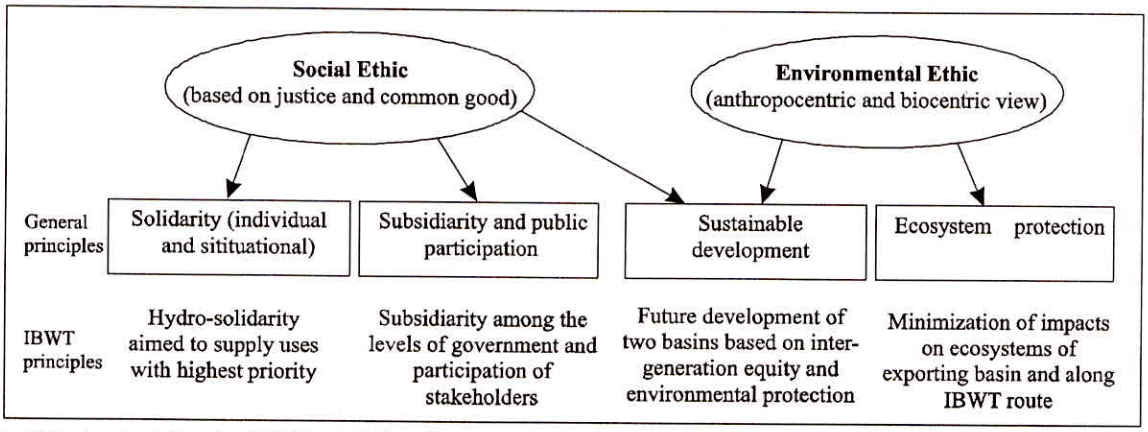

Fig. 5: Some ethical principles for IBWT, deriving from general principles of social and environmental ethics

According to the above cited principles, the specific principles to be adopted for IBWT can be formulated as follows:

1. hydro-solidarity aimed to supply a hierarchy of uses, independently of their location either in the exporting or recipient basin. In particular a hierarchy of uses can be formulated giving highest priority to drinking water demand (as a human right which overcomes the boundaries of river basins or administrative units). Then, water needs for agricultural uses should be considered linked to farmer subsistence, agricultural landscape protection and food security requirements, followed by ecological needs. Finally the needs for industrial and energy uses should be taken into account;
2. resolution of the conflicts between the basins through cooperation among the different levels of government, guaranteeing the participation of all stakeholdêrs to decision process;
3. sustainable development of both basins, based on inter-generation equity and environmental protection, which leads to limit time-horizons of water sharing decision and to adopt institutional tools able to guarantee a flexible management;
4. minimization of impacts on environment and ecosystems in exporting basin and along the route of IBWT.

PROPOSED CRITERIA FOR A COMPREHENSIVE FEASIBILITY ANALYSIS

Hydrological Feasibility

Hydrological feasibility of a water transfer aims to check both the conditions of a water surplus in the river basin from which water is derived and the conditions of a water deficit in the receiving basin. The following main criteria are suggested to develop a homogeneous and, in some way, robust analysis:

1. probabilistic estimate of available water resources referred to hydrological year and to inter-annual dry periods (e.g. low flow season), by fixing a common exceedence probability (or return period) for both involved basins. Such analysis should consider the non-stationarity (negative trend) detected in the historic streamflow series, by correcting the estimate carried out on historic record according to a precautionary principle with reference to expected climatic change effects;
2. evaluation of medium and long-term demands, based on homogeneous criteria for the assessment of future population, surface of irrigation districts and related crops, industrial estates and in the selection of unitary water needs for each use for both basins. A longer time-horizon could be chosen for donor basin if priority to future development is or should be assigned according to a political decision; but such choice should not be in contrast with the priority list of uses, deriving from the solidarity principle based on human rights and equity principles. The future demands for each use should consider the historic unitary consumptions with the necessary modifications with reference to likely scenarios deriving by technological innovations and users behaviours oriented to water saving, and losses reduction in all stages of withdrawal, conveyance, regulation and delivery of water to final users;
3. computation of surplus and deficit conditions in the two basins, able to objectively justify a water transfer project first of all require to compute if recipient basin presents a permanent water deficit or temporary shortage (due to drought events) and if exporting basin has adequate surplus. This simplified balance between resources availability and demands in each basin, including also the "in-stream flow" considered either as constraint or

demand for ecological and/or water quality control, is necessary but it is not sufficient to justify the IBWT. Indeed it should be followed by a more detailed analysis of the water supply systems existing in the two basins (including reservoirs for water regulation) aimed to estimate the effect of the water transfer on the performance. In particular the comparison of the simulation of the two separate supply systems and of the complex whole system can help to quantify the improvement of the performance due to IBWT, in terms of reduction of permanent scarcity and shortage conditions in recipient basin, without negative effects on donor basin. Also if the water transfer is primarily oriented to divert surface water resources, the condition of surplus and deficit should include other conventional and not-conventional resources of the two basins: groundwater amount should be estimated by a simplified computation of safe yield and non conventional resource amount should be computed on the basis of the wastewater treatment plants and desalination plants in operation or under construction or planned whose completion is highly probable.

Economic Feasibility

In addition to the financial feasibility analysis carried out by following the standard procedures adopted for any great infrastructure, an economic feasibility study of water transfer, based on "cost-benefit analysis", has to include some additive categories of costs and benefits and an adequate choice of criteria to be adopted for checking feasibility (see Pearce and Turner, 1990). Figure 6 shows the main elements to be considered for cost and benefit computation and for testing feasibility. Besides the investment, maintenance, operation and replacement costs, the compensation costs to the area of origin of water also have to be computed, particularly oriented to recover direct (monetary) damages of the project due to water diversion (e.g. reduced hydro-electric production) or indirect damages due to in-stream flow reduction on local communities and eco-system life. Clearly, the latter are difficult to estimate, since they are connected to recreation, landscape and heritage values, which can differ significantly between the basins.

On the other hand, benefits have to include not only the value's increase of goods and services directly connected to water transfer, (with limits regarding surplus of agricultural productions), but the indirect benefits as well, by taking into account the use of not-occupied workers.

The criteria for checking the economic feasibility of the IBWT project can be formulated according to the standard procedures of cost-benefit analysis, including externalities referring to environmental impacts. The feasibility analysis should include also the comparison of the IBWT project with other alternatives of water supply to be carried out on the basis of an economic criterion or better on the basis of a multicriterion approach.

Computation of costs with reference to:		*Computation of benefits with reference to:*
- Investment for hydraulic structures and impact mitigation - Operation, maintenance and replacement - Compensation of direct and indirect damages in exporting basin	-	- Worth of goods and services directly connected to water transfer (excluding the surplus of agricultural products) - Worth of products due to external economy - Worth of the use of not occupied workers
↓		↓

Check of economic feasibility
- feasibility of the project:
  income's increase due to the IBWT in the recipient basin greater than the total cost of IBWT and income's decrease in the exporting basin (according to the cost-benefit * NPW = B – C > 0;
  B/C > 1; IRR > SRR
  with: NPW = Net present worth; B = present benefit; C = present cost;
  IRR = Internal rate-of-return; SRR = Social rate-of-return)
- comparison with other supply alternatives:
  IBWT project preferable to the best supply alternative according to economic or multicriterion analysis

Fig. 6: Criteria for economic feasibility of an IBWT

Environmental Sustainability Assessment

The environmental impact assessment is a key issue for water transfer feasibility, since several projects have been cancelled due to very severe environmental impacts downstream the diversion and/or along the route of the transfer.

The assessment should include all impacts on exporting river downstream to the diversion (e.g. minimum ecological flow, sediment transport, coastal protection, etc.), all impacts on recipient river (e.g. due to different water quality) and on the route of water transfer (e.g. consequences on natural parks and reserves).

Two interrelated assessment documents are required. The first one (Table 2) will provide the comparison of

Table 2: Comparison of the Impacts of IBWT with Those of Other Alternatives

Criterion	*Value for Alternative(*)*		
	SQ	*WT*	*OA*
COMPATIBILITY WITH WATER RESOURCES PLANNING			
ACHIEVEMENT OF PRECAUTIONARY PRINCIPLE: - reliability of water supply - stability of costs and agricultural market			
MINIMIZATION OF IMPACTS ON NATURAL RESOURCES - air quality - water quality - soil quality - energy use			
MINIMIZATION OF IMPACTS ON ENVIRONMENT ECOLOGY AND LANDSCAPE - river ecosystems - coastal ecosystems - landscape			
CONTRIBUTION TO SUSTAINABLE LAND DEVELOPMENT - rural and urban areas - exporting and recipient basin			
CONTRIBUTION TO SOCIAL STABILITY - safeguard of work - impacts on public opinion			
(*) SQ = status quo; WT = water transfer project; OA = other alternatives			

Table 3: Comparison of the Alternative Routes of the Selected IBWT

Criterion	*Route*		
	a	*b*	*c*
COMPATIBILITY WITH WATER RESOURCES PLANNING			
IMPACTS ON EXPORTING BASIN: - on current and future uses - on instream flow downstream diversion - on river ecosystems - on public opinion			
IMPACTS ON TERRITORY OF THE ROUTE: - environmental impacts on parks, reserves, SIC - socio-economic impacts			
IMPACTS ON RECIPIENT BASIN: - quality of water for municipal and irrigation uses - guaranties levels for different uses - cost of transferred water - impacts on chemical, biologic characteristics of water bodies - hydrological consequences - impacts on landscape of supplied areas			

the impacts of water transfer with the ones produced by other supply alternatives to cope with water scarcity problems (e.g. reuse of treated wastewaters or desalination, etc.); such document should preliminarly compare the IBWT with reference to other strategies and not be prepared after the technical design has completed its itinerary in order to justify the measures to mitigate the impacts. The second one (Table 3) will deepen the analysis comparing environmental impacts of various transfer's alternatives, which differ for route and/or number and size of hydraulic plants.

CONCLUSIONS

The inter-basin water transfers, in spite of the increasing controversies recently experienced in several developed countries, still represent a potential solution to water scarcity problems, which likely will be exacerbated in arid and semiarid countries by the expected consequences of climatic changes.

The paper has discussed the necessity of developing a list of criteria, able to guide in the feasibility analysis of IBWT, in order to prevent or reduce the controversies or conflicts which in many cases have hindered the implementation of proposed projects.

Particular emphasis has been given to some general principle of social and environmental ethics, from which derive specific criteria to be adopted for comparing different solutions.

The main ethical principles include: interbasin solidarity, subsidiary and public participation, sustainable development and ecosystem protection.

The identified specific principles for IBWT implementation include: (i) hydro-solidarity in order to supply prioritary uses, independent from their location; (ii) subsidiariety among different levels of government able to resolute possible disputes and founded on public participation; (iii) sustainable development based on inter-generation ethic which requires to limit time-horizon of water sharing agreement and to adopt adequate institutional tools able to guarantee a flexible management; (iv) impacts minimization of environment and ecosystems which leads to adopt all measures necessary to reduce damages and to protect fauna and flora downstream the diversion in exporting basin and along the route of IBWT.

Then criteria for a comprehensive analysis, including hydrological and economic feasibility and environmental assessment have been discussed, in order to evaluate the conditions which can lead to prefer a large-scale engineering project to other apparently less-impacting alternatives for improving the supply-demand balance in a water deficit basin.

A summary of the main proposed specific criteria, that try to answer to the list of questions before presented, is as follows:

1. the computation of water deficit in recipient basin and water surplus in exporting basin has to be carried through a balance between water resources (including all conventional and non-conventional sources of water) and the water demands (under scenarios which consider the most efficient use of water and saving measures), including "in-stream flow" requirements. A more detailed analysis should include as well as the evaluation of performance's increase of the whole water supply system considering the water transfer;
2. the comprehensive economic assessment of the project should include the direct and indirect benefits of IBWT as well as the costs of compensation measures to the donor basin for covering damages and potential lacking of future development;
3. the environmental impact assessment should be aimed to preliminarly compare the sustainability of IBWT with respect to other supply alternatives instead of simply identifying measures to mitigate the impacts of a IBWT, and to improve the preferable route of transfer once water transfer has been selected.

Finally the implementation of transparency in information and public participation is required as compulsory in all stages of the decision process of a IBWT.

The main conclusion of the present paper is that the solution of IBWT controversies should be framed within a vision of ethics for water utilization based on responsibility principle that takes into account future generations needs and nature protection according to an anthropocentric ethical option enlarged to consider also biocentric point of view. Applicability of the proposed criteria is subject to their acknowledgment in international legal tools on water resources such as an updated version of the UN Convention for non-navigational uses of water courses.

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