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ENVIRONMENTAL IMPACTS OF WATER RESOURCE DEVELOPMENT AND MANAGEMENT

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INTRODUCTION

Environmental issues in the Southern of the Mediterranean, like in most other developing countries, have received limited attention in the past. However, with increasing human activities, protection of land and water resources of the region is becoming a priority consideration.

A reasonably clear and detailed picture of environmental issues confronting the land and water sector did not exist. Nor any accurate estimates on the cost of land and water degradation to the national economy. The cost is already significant at present, and if no drastic action are taken, the existing trends show that it is likely to become even higher during the 1990s.

Water pollution already is a serious problem in certain countries of the Mediterranean. While a reasonable clear picture exists in terms of salinity of water, availability of usable information on other water quality parameters is very limited. Time series data on various water quality parameters are basically non existent. Some data are available on a few parameters, but their potential use for water quality management is extremely limited since they are collected at long intervals, often in a random time sequence, and only at a few selected places.

In the nineties, the main challange facing the water resources profession is how to maximize all the positive impacts of any water development present, planned or already operational and minimize the adverse impacts.

Therefore, this paper will concern with the fundamental issue of how to accomodate water resources development within the context of environmental preservation and improvement.

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AREAS OF ENVIRONMENTAL IMPACTS

Primary impacts	**Secondary impacts**	**Tertiary impacts**
- caused directly by project inputs	- caused by output projects (water flow regulation channelization)	Are the resultant of secondary impacts
- attributed directly to a project activity	- indirectly attributed to the project activity	
- Easy to measure	- more difficutl to predict and measure	

The distinction between primary secondary and tertiary impacts could be often arbitrary.

In the ecosystem, impacts are usually complex and one impact may lead to another, resulting in chain-actions. For example deforestation could contribute to increased reservoir siltation wich could lead to a loss in down stream fishery, causing malnutrition which in turn may increase sickness and a major impact may be often due to a combination of factors. The causal linkages between impacts may not be direct or clear-cut.

Impacts could be also conceptually divided into two brand categories:

ENVIRONMENTAL IMPACT CATEGORIES

Short term impact occur during planning, constructing and immediate post construction phases
Many adverse impacts: noise, soil disturbance, air pollution, disruption of transport.
Serious environmental social and sanitation problems

Long term impact stem from the presence of:
- Large man made lakes
- Development of perennial irrigation instead of seasoneal one
- alternation in the ecosystem of the area
- changing in the socio-economic

Long term impacts could be grouped in the followings:

LONG TERM IMPACTS

Physical-chemical impacts

- Impacts on water quality:
  siltation, depletion of dissolved oxygen, nutrients accumulation, salt control
- Impacts on ground water:
  Salt content;
  Contamination of fertilizers and pesticides;
  Ground water table rais
- Impacts on soils:
  Soil degradation hazards;
  Water logging and salinity;
- Earthquakes
- Ground water mining
  excessive ground water table with drawal
- Effects on climate:
  New microclimates created by large reservoirs

Biological impacts

- Impacts of living organisms:
  Flooding of reservoirs area;
  Fishery in the reservoir;
  Nutrient level in water and acquatic weeds;
- Impacts on heath
  water related diseases

Socio-economic impacts

- Impacts on the economy
- Impacts on archeological sites
- Impacts on socio-cultural structures

ENVIRONMENTAL EFFECTS OF WATER RESOURCES DEVELOPMENT

Environmental issues related to water resources encompass a wide range of concerns, including public health, pollution of surface and ground waters, lowering of ground water tables, salt water intrusion, reduced sedimentation in flood plains, changes in river hydrographs, reduction of wetland area, increased riverbed erosion and costal and marine pollution.

Concerning the Mediterranean region, broadly, several types of environmental effects of water surface development may be recognized.

The first one is disruption of human settlements and human activities. For example, the formation of lake Nasser in Egypt and Lake Nubia in Sudan necessitated the displacment of more 100.000 people. Occasionally, particularly, when a drought occurs, such

disruptions are very large.

A second type of environmental effects associated with water development in some parts of the Mediterranean region is the creation of favorable habitats for the parasitic and water-borne diseases, such as schistosomiasis, malaria, filiariasis and river fluke infections.

Large water resources devolopment projects in Africa (such as a Lake Karabia in Zambia/Zimbabwe, lake Volta in Ghana, lake Kainji in Nigeria and Lake Nasser in Egypt) have almost invariably to considerable increase in the incidence of water based infections and those caused by water related insect vectors (Hughes and Hunter 1971; Miligan and Thomas 1986; Obeng 1978).

Among diseases spread by water development projects, schistosomiasis (Bilharziasis) [Sub-Sahara Africa, Arabian peninsula, the Nile valley Egypt, Iran a part of the Midle East, Brazil, Venezuela, China, Japan and the Phillipines]. The number and its victims is currently to be estimated to be 200 million. In Egypt the estimates for the increase in the schistosomiasis cases due to the Aswan High dam are between 2.6 to 6 million (Thani and Tam, 1990). Malaria, whose victims in the world number 200 million, is also often associated with water development projects. The construction creation of the Volta River Dam resulted in the creation of a serious potential mosquito breeding area (Lambrecht 1981).

A third type of environmental disruption is of physical or chemical nature, resulting from the alteration of land use, and/or changes in the surface and groundwater regimes, as a consequence of the construction of irrigation projects or flood control works, such as dam or levees. Soil salinization and water logging due to the lack of adequate drainage facilities is a classic example of such environmental problems. In the Euphrates valley in Syria and the lower Rafadain plain in Iraq, over 50 percent of irrigated land suffers from these effects.

In Iran such problem affect 15 percent of the total area of the country. In Pakistan, more than 13 million hectars out of about 15 million irrigated hectars are severly affected by soil salinization and water logging (El-Gabaly, 1977). More than 20% of 30 million hectars of irrigated land in Egypt, Iran, Iraq and Pakistan are affected by water logging and salinization problems. It is estimated that between 1985 and 2000 the irrigated land area of the world will double, and the problems of salinization and alkalinization will increase proportionally. Globally water-logging and salinization are reducing the fertility of sum 1 to 1.5 million hectars of fertile soil annually (Biswas 1978).

Another of the most serious environmental disruption of this category is siltation. Reference is frequently made to reservoirs that were built for flow control or generation of hydroelectric power where the rate of accumulation of sediment was so rapid that a major reduction of reservoir capacity occured within a few years of the construction of the associated dam.

The sanmen Dam on the Huang He River in China provides an especially dramatic illustration. By 1984 the generating capacity of the associated hydroelectric plant had been reduced by more than 75% of that available 24 years earlier. The useful like of the Ambukloo Reservoir in the Phillipines has been reduced from 60 to 32 years due to increasing sedimentation. Similar difficulties have been experienced with water projects in various parts of Asia and Africa (Biswas 1984).

Finally, the fourth category of environmental effects of water resources development deals with flora and fauna, including impacts on ecological systems taken in a broad sense in this term. For example, ecological problem that resulted from dam construction in certain countries of Mediteranean is that of the spread of aquatic weeds. Serious difficulties have been encountered as a result of weed growth in the Aswan reservoir. Various types of aquatic weeds covered more than 80 percent of the reservoirs in Egypt. In 1990, 13.000 Km of canals and drains were estimated to have been infected by submerged aquatic weeds, and another 1.900 Km were covered by water hyacinths (Abu Zeid and Rady 1991). The spread of weeds has a number of secondary impacts, notably water losses through evapotranspiration. Costs of weed clearing may be in the order of millions of dollars, and sometimes the effects of the remedy may be even more destructive and hazardous than the weeds themselves. The use of herbicides is an example.

It is clear from the foregoing that environment has a wide variety of meanings and that environmental disruption can take many forms. In some instances, water projects may even result in the destruction of the resource on which they depend. But it is also apparent that severe damage of water resources may be inflicted by activities other than those directly related to water resources development. Unfortunately many essentially "non-water" activities are decided on without due consideration given to their potential impacts on the aquatic environment. In fact, sometimes they just happen as a result of specific social and economic conditions, for example, the uncontrolled expansion of the urban areas caused by migration of population from the poverty stricken rural regions. The excessive

use of fertilizers and pesticides to increase crop yield is another problem of a "non-water" activity having serious consequences for water quality. This is effecting the more productive agricultural areas in the Mediterranean countries. It is important, therefore, to consider linkages between environmental problems. Of an important to point, that remedial measures must be spread over a number of "non-water" sectors and activities, taking into account primary and secondary environmental effects as well as their cumulative impacts.

The environmental effects of water resources development are real and it seems likely that man can cope with them effectively only through a very close integration of natural and social sciences, which should be adequately reflected in educational processes and institutional arrangements.

ENVIRONMENTAL IMPACTS OF WATER DEVELOPMENT IN THE MEDITERRANEAN REGION

Analysing the situation in the Mediterranean Countries, it seems obvious that there is increasing pressures on International Institutions to take the lead in responding to concerns about environmental deterioration. No real efforts are devoted by the institutions to develop policies that ensure taking the initiative in dealing with these problems, instead of being seen as merely reacting to specific challenges as they arise.

From the environmental point of view much unhappiness with water projects stems from the casual way in which environmental consequences are handled as a last minute consideration, rather than being integrated into project design from the beginning. Big offenders include irrigation projects in which drainage issues are neglected in the initial planning, navigation projects in which the disposal of dredged materials is haphazard, and flood control projects which ignore flood plain fisheries. In all of these cases adequate pre-planning guidelines could substantially reduce the environmental impacts. There are other projects, for example large dams, which have major environmental impacts that cannot be mitigated, such as loss of habitat, loss of fertile bottom lands, destruction of forests, and sediment trapping, in addition to the social impacts of moving large numbers of people from their homes and farms.

IMPLICATIONS OF WATER DEVELOPMENT ON THE ENVIRONMENT

There are three important issues that should be noted in any discussion of the implications of water development on the environment. First, the impacts of water development on environmental health are many. Some of these impacts are direct and comparatively easy to identify and to predict in advance. Others could be indirect and project-specific and thus often prove to be difficult to foresee and even more difficult to quantify. Most water resources projects produce a mixture of these two types of impacts. As is to be expected, it is less difficult as a general rule to predict and control primary impacts than secondary and tertiary impacts. Thus for impact analysis of any medium to large-sized irrigation project a substantial number of specific and interrelated factors have to be analysed, both concurrently and sequentially, in a coordinated manner within an overall framework, by a variety of professionals, based often on incomplete or unreliable data. Considering the methodological limitations that are inherent in such impact analysis, it is a difficult task under the best of circumstances.

Secondly, environmental impacts of projects, both direct and indirect, are never confined within the project boundary. Many of the impacts occur far from the project area. Accordingly, it is not possible to define a precise geographical boundary which could be said to contain all the impacts.

Thirdly, the time dimension of the impacts is another complicating factor. Certain impacts can be immediate, and thus can be identified during the implementation phase or soon there after. Other impacts, however, could be slow to develop, and thus many not be visible in the early stages. For example, some unanticipated changes in the ecosystem and the environment could take more than a decade of operation of a project before they begin to appear. For many impacts it is not possible to forecast the timing of their occurrence with any degree of reliability. A typical case is salinity development in irrigated areas, which could take 15-25 years in certain projects, but in others the problem may appear within 2-3 years, depending on physical condition, drainage facilities, operation and maintenance procedures, and managment practices. The time dimension also makes direct comparision of the impacts of different water development projects a difficult process.

IMPACTS ON THE ENVIRONMENT AND HEALTH OF THE INCREASED USE OF WATER IN THE MEDITERRANEAN COUNTRIES

Water resources are continuously subjected to development presure in almost all countries, particularly in arid countries. As a result, the quantities of available water are declining and the quality of water is rapidly deteriorating.

Declining supplies are obliging cities to seek water furtheraway from their countries. Water is being transferred over long distances which is very costly and can lead to interregional or even international conflicts.

Urban water supplies are also experiencing a decline in quality. Rivers and streams which supply cities also receive urban waste water and industrial effluents, which means that they cannot be used anymore as a water supply. Toxic chemicals from industry, pesticides, nitrates and phosphates from agriculture are all contributing to the contamination of the fresh water resource.

Groundwater is usually the best source of water because of the filtering capacity of the soil, and it is usually the first used. As such it is therefore under increasing pressure. The quantity of water available is declining as a result of overpumping, leading to a drop in the water table. In costal areas this can lead to salt water intrusion and subsequent salt contamination of the aquifer. Also when the water table has dropped the soil may subside, damaging infrastructures. Groundwater quality is also deteriorating because of human pollution from wastewater and industrial discharges as well as from nitrate, herbicides and pesticides contamination. Groundwater bodies sometimes undergo irreversible deterioration when polluted by bacteriological and toxic pollution from waste water in urban areas with no sewage systems. For these reasons, many aquifers bodies cannot be used directly for human consumption and require costly treatment.

The construction of large reservoirs for water storage can have a serious and complex impact on the environment that is often difficult to quantify and identify. When large dams are built, the river regime changes and influences the behaviour of the whole hydraulic system from the headwaters to the outflow. Flora and fauna living along the river suffer the effects of this change, whills the population living in the area to be flooded must move elsewhere permanently. Some adverse effects can sometimes appear years after

the start of reservoir operations. Reservoirs are also vulnerable to the inflow of nitrates and phosphates and toxic chemicals. Fertilizers, such as phosphates, are creating eutrophic systems in reservoirs and the degraded water quality makes for inferior water supplies.

WATER QUALITY

An assessment of water resources is incomplete without knowledge of the quality characteristics as assessed by their physical, chemical and biological constituents. These constituents may originate naturally from the environment (e.g. soils and geological formation) or from wastes discharged as a result of agriculture, human settlements and industrial activities. They are introduced either from point sources (mostly industrial and municipal), which are manageable, or from non-point sources (mainly agricultural), in which case management is more difficult.

The concentrations of the constituents simply express the status of the water in physical, chemical and biological terms, but quality can only be discussed meaningfully when it is related to a specific use. In such cases, guidelines must be given on the concentrations of various constituents which should not be exceeded in order to avoid impairing the water for any particular use.

Until 1987 no attempt had been made to assess globally the quality status of regional fresh waters. This was due to lack of data from most countries, particularly from the developing countries, where water quality data were not collected on a regular basis.

POLLUTION PROBLEMS COMMON TO ALL WATER BODIES

The common contaminants were found to be heavy metals and organic micropollutants. The pollution problems were classified into those that were common to all the fresh water bodies and those were specific to rivers, lakes/reservoirs or groundwater. The classification is presented in Table 1.

Table 1. Occurance of major pollution problems in different types of water body (source: WHO/UNEP, 1989)

Type of water body	Water pollution problem	
	Specific to water body	Ubiquitous occurance
Rivers	Pathogens Organic matter Suspended matter Acidification	Heavy metals
Lakes and reservoirs	Eutrophicatio Acidification	Organic
Grounwaters	Salinization Nitrates	Micropollutants

In the remainder of this century water quality issues will become increasingly important. Monitoring and environmental management measures to preserve the quality of existing groundwater and surface water resources will take a prominent place on the agenda of overall water resource use planning. Recently, different views have been expressed concerning the relative importance of water quantity versus water quality for health improvement, and this on going discussion will have to result in balanced view on the issue, taking into account local epidemiology, ecology and economy.

New technologies will need to be applied to detect and monitor water resources in an integrated manner. Water quality is being checked through the Global Environmental Monitoring system by a network of national institutions. These data may be complemented by Remote Sensing (RS) observations of watersheds and river basins, and they will be increasingly analyzed with the use of Geographic Information Systems (GIS). It is of great importance to create intersectorial networks in which countries can apply these new technologies for a sound and integrated management of their natural resources. Ministries of health will have to step up their health monitoring and epidemiological assessment activities to provide such systems with adequate data so as to elucidate the linkages between environmental change and human health status.

WATER QUALITY IMPACTS ON ENVIRONMENT AND HEALTH

Deterioration in the quality of this vital resource has very serious implications for health and the quality of life. Access to it becomes a right requiring equitable distribution to all society. Attempts have been made in most countries to ensure that even the poorest sections of the population have access to good quality drinking water, but much effort is still needed to attain this objective. Globally, there are at present 1.2 billion people suffering from diseases caused by drinking polluted water or transmitted by inadequate sewage equipment. Some 15 million children under five years old die annually in developing countries, mainly following an illness caused by water. These diseases also play a significant role in adult mortality and sickness. Poor health caused by water-related diseases and unsanitary practices is very costly to the economy in terms of work days lost and reduced productivity. The pollution of water supplies may be aggravated if drinking water supply programmes are not accompanied by appropriate sewage systems.

Many developing countries of the meditteranean do not have the operational means to assess their water quality. Without this information, they may be unaware of problems and perhaps endangering their population's health. However, some pollutants bioaccumulate and the health effects may not be detected for some time. Therefore, the monitoring and quality control of water is of prime importance for human health and in those countries, much effort is now being directed towards preventing pollution and treating polluted water since new and sophisticated methods of water treatment are available. Monitoring and control must be carried out systematically, especially in areas where there is a lot of industrial activities.

The increased use of water in cities is inevitably increasing discharges of waste water (the average percentage discharged into the sewage system amounts to 80 per cent). The volume of waste water will thus continue to increase, with a resultant proportional rise in expenditure on collection network and wastewater treatment plants. The self-cleaning capacity of recieving water is rapidly diminishing. In many countries, the water supply has run ahead of waste water management system. A great effort must now be made to close this gap and preserve the environment through waste water treatment.

Increasing water pollution from industrial and domestic sources, if allowed to grow un checked, is likely to reduce the amount of water available for various uses in future. In

addition, the total economic and health costs to the country due to unchecked pollution would be sustainable. For example, the second pumping station Rehabilitation Loan of the World Bank conlcuded that excessive pollution of drainage waters around Alexandria reduced the lifespan of irrigation pumps from 20 years to only 4 and required more sophisticated pumps and piping at higher costs (Abu Zeid adn Rady 1991). The irrigation system in Egypt, is currently kept functional by some 675 pumping stations, which clearly cannot be allowed to deteriorate due to water pollution.

ENVIRONMENTALLY - SOUND WATER MANAGEMENT

Any attempt to develop water resources results in some modification of the environment. Sometimes the impact is confirmed mainly in the river region, aquifer or lake itself, as in an alternation in the normal flow or the quality of the water body. In other instances the effects are much more widespread and may result in considerable alterations in land resources, forests or fisheries. Beyond this, water development may have major impacts on human settlements and economic activities. The seriousness of these impacts depends upon the ability of the various physical, natural and human systems to absorb them, as well as human perception about them (Biswas, 1984).

To a significant extent the environmental impacts of water management are beneficial, particularly when they open up new avenues for economic development or social improvement without serious impairment of the resource base or the ecological system. Often, however, environmental consequences are adverse, varying in the degree of their intensity and social acceptability.

It should be clear that environment has a wide variety of meanings and that environmental disruption can take many forms as said before. Severe damage may be sustained by other resources or by activities in addition to those directly related to water development. At the same time experience across the world indicates that many of the problems of reconciling development and environment result from a failure to consider them simultaneously.

Environmentally-sound water management implies that:

1. development be controlled in such a way as to ensure that the resource itself is maintained and that adverse effects on other resources are considered and where possible ameliorated;

2. options for future development are not foreclosed; and
3. efficiency in water use and in the use of capital are key criteria in strategy selection.

Recognizing these ideas is one thing; translating them into action is another. More specifically, what is required to foster the adoption of the three elements noted above in planning and policy making are: namely, the recognition of concepts of environmentally - sound development and resilience, the incorporation of a more comprehensive perspective and the pursuit of higher levels of efficiency.

CONSTRAINTS TO ENVIRONMENTALLY SOUND MANAGEMENT

A comprehensive and critical analysis of existing literature on environmental aspects of water development in the Mediterranean indicates that there are many constraints which limit the potential application of available knowledge by water professional and decision-makers in developing countries. On the basis of this analysis, the following four major constraints can be identified:

1. incomplete framework for analysis;
2. lack of appropriate methodology;
3. inadequacy of knowledge; and
4. institutional constraints.

It should be noted that the four major constraints identified are not independent. On the contrary, they are often closely interrelated.

INCOMPLETE FRAMEWORK FOR ANALYSIS

The framework currently used for analysing and considering various environmental impacts associated with water development projects is overwhelmingly biased towards assessing only the negative impacts.

Concerning large scale water development, for instance the newly built Aswan High Dam, a lot of articles were published concentrating only on the serious negative impacts of the Aswan High Dam, such as the loss of the Mediterranean fishery, an increase in schistosomiasis, salinity development, a reduction in the fertility of the Nile

Valley through the absence of silt deposition, and coastal erosion of the Nile Delta. But, still this does not mean that this dam should have not been built. It has doubled Egypt's electricity generating capacity, helped prevent disastrous floods, improved river navigation, created a vast potential fishery in the reservoir that has more than compensated for the sardine loss in the Mediterranean, attracted more tourism and made the water resources use much more reliable in municipal, industrial and agricultural development.

What is thus needed is a balanced framework for analysis which will identify both positive and negative impacts. The next step should then be how to maximize the positive impacts and minimize the negative ones. A framework that considers only the negative impacts and ignores the positive ones is both incomplete and counterproductive.

LACK OF METHODOLOGY

A review of the processes currently used by developing countries to incorporate environmental issues in water management indicates that the methodologies available at present do not appear to satisfy the special requirements of those countries. While the environmental impact asessment (EIA) process was made mandatory in several industrialized countries, its actual use so far in developing countries has been somewhat slow. The reason for this slow acceptance is the lack of an operational methodology that can be successfully applied in the developing countries with limited expertise, resources, data and time. The EIA methodologies that are being used in industrialized countries are not directly transferable to developing countries for various socio-economic and institutional reasons (Biswas and Kindler 1989).

The complex, lengthy, expensive and time-consuming EIAs as practised in developed countries are not the right tool to assess the impact of water development projects in developing countries. It is also important that in addition to being appropriate to local circumtances they should be affordable in terms of cost and maintenance. Many hydrological services in the developing Mediterranean Countries have not been guided on these latter aspects. It is not uncommon to find that equipment has been acquired without ensuring that it can be operated and maintained properly. Hence, the life span of equipment is unduly shortened, thereby wasting scarce resources.Also it is necessary to

develop guidelines which can actually be used by professionals for water management in planning and managing projects.

LACK OF ADEQUATE KNOWLEDGE

The results presented so far show that there is some working knowledge available about the Mediterranean's water. However,as can be seen from a comparison of the various estimates, differences exist with regard to the water balance components and the water resources at the various levels.

Those scientists who have made contributions to this knowledge, pointed to the lack of adequate data on the hydrological cycle, the lack of sufficient areal coverage of the data and their representativeness, the gaps in data, the quality of data, and in some cases problems of access to data even if they are available. In addition, there are questions raised about the adequacy of the scientific basis, methods and techniques used in making the assessments.

There are many areas where adequate technical knowledge may not exist for getting reliable answers. Equally, there are areas where "conventional" knowledge can at best be dubious and at worst totally erroneous.

The other problem is the absence of data on pre-project conditions in terms of environment- and health-related factors. Even now, when some baseline surveys are being carried out on pre-project conditions, environmental and health issues receive virtually no attention.

INSTITUTIONAL CONSTRAINTS

A sectorail approach to water development is a major institutional constraint in all developed and developing countries, and this has an important bearing on the sustainability of projects.

There are many reasons for this situation, but one of the most important is the division of responsabilities between the various ministries that look after various water-related issues. Because of long-standing rivalries, the coordination and cooperation between the various ministries leave much to be desired. And yet in any large-scale water

development project all these issues must be integrated within the project area. While it is easy to point out this necessity, how this integration can be effected in reality in the field is a very complex and daunting task.

As a matter of fact there are many constrains to achieve environmentally sound water management in most developing countries of the Mediterranean. Their importance could vary from one country to another, and sometimes even from project within the same country. Often the constraints are closely interrelated: one contributing to the other and vice versa. To over come those constraints, it is primary needed to fullfill the following existing gaps:

- Lack of appropriate and consistent policies of water development for both large- and small-scale projects.
- Absence or inadequacy of monitoring, evaluation and feedbacks at both national and international levels.
- Lack of proper policies on cost recovery and water pricing or, if policies exists, absence of their implementation.
- Lack of professional and technical manpower and training facilities.
- Lack of beneficiary participation in planning, implementation and operation of project.
- Lack of knowledge, and absence of appropriate research to develop new technologies and approaches, and absence of incentives to adopt them.
- General institutional weaknesses and lack of coordination between various ministries such as water, agriculture, environment, planing and other.

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