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Irrigation in the World - the Future will not be like the Past

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1 Introduction

The irrigation of arable land and pastures has been practised around the world for thousands of years. With the aid of irrigation it was and still is possible to grow crops with reliably high yields in all arid regions of the earth. At the same time, irrigation has guaranteed an adequate and continuous supply of foodstuffs, without which it would not have been possible for sophisticated civilisations to develop along the Nile (Egypt), the Tigris and Euphrates (Turkey, Syria and Iraq), the Indus (Pakistan and India), the Ganges (India and Bangladesh) and also along the Hwang Ho (Yellow River) in China. It is estimated that by the year 1800 about 8 million hectares of land were irrigated around the world, but 100 years later this figure had increased to about 40 million hectares, partly as a result of modern sprinkler irrigation systems that had become available to gardeners and farmers. By the year 1950, the irrigated area had risen still further to a total of about 94 million hectares on a world-wide basis. Irrigation farming continued to grow at a considerable rate in subsequent years, especially during the so-called „Green Revolution". Nowadays, about 250 million hectares, or 17 % of the world's agricultural area, are irrigated, producing about 36 % of the world's food supplies. In terms of sales value, the contribution made by irrigated agriculture to the world's total agricultural output is estimated at just under 50 %; this is probably due to the fact that in many irrigated areas farmers grow a greater proportion of crops with a high market value.

On a regional basis, it is estimated that around 60 % of the value of crop production in Asia is grown on irrigated land. This includes about 80 % of Pakistan's food, 70 % of China's food and over 50 % of the food in India and Indonesia. In the Middle East and North Africa, more than one third of the region's crop production by value is irrigated, including all the food grown in Egypt and more than half of that grown in Iraq and Iran. A relatively small proportion of agricultural production in Latin America, around 10 %, is grown under irrigation, but half of the crops grown for export in Chile and Peru are irrigated. Madagascar produces more than 20 % of its agricultural output and food on irrigated land. Sub-Saharan Africa has the smallest regional area under

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irrigation, and produces an estimated 9 % of its total food production on irrigated land (YUDELMAN, 1994).

Therefore, the irrigated sector performs an essential task in meeting the basic food needs of billions of people in the world, especially in Asia. It has provided more than half of the two most important basic staples and close to a third of all food crops. In the future, irrigation farming and gardening will have to provide an even larger proportion of total food supplies, especially in Asia.

2 Problems of Today - Challenges for the Future

Notwithstanding the great importance of irrigation for the production of foodstuffs and renewable raw materials, the sustainability of irrigation farming in developing countries is seriously at stake. Country-wide, regional and seasonal water scarcity in developing countries poses severe problems for national governments and the international development community. The challenges of growing water scarcity are exacerbated by the increasing costs of new water, wasteful use of already developed water supplies, degradation of soils in irrigated areas, depletion of ground water, pollution of water and its impact on human health, and the massive subsidies and distorted incentives which govern water use. Apart from these problems, it is clear that the rapid development in irrigated agriculture in developing countries during the past three decades has been achieved with remarkably little change in organisational frameworks, irrigation technologies and the institutional setting of agriculture.

2.1 Increasing Cost of New Water

According to Rosegrant (1995) new sources of water are increasingly expensive to exploit, limiting the potential for expansion in new water supplies. If we look at the situation in India, Indonesia, the Philippines, Sri Lanka and Thailand we find that the real capital costs for the construction of new irrigation systems, on an unweighted average, increased from US$ 1,744 per hectare in 1966-69 to US$ 4,385 per hectare in 1986-88. All countries show large increases in the cost of investment per hectare over the past two decades. In India and Indonesia, the real costs of new irrigation systems have more than doubled since the late 1960s and early 1970s; in the Philippines, costs have increased by more than 50 %; in Sri Lanka, they have even tripled; and in Thailand they have increased by 40 %. In Africa, irrigation construction costs have been even higher than in Asia, due to numerous physical and technical constraints. The average investment cost for medium and large-scale irrigation with full water control is estimated at US$ 8,300 per hectare in 1992 dollars (FAO, 1992). These cost increases, in combination with until recently declining cereal prices, result in very low rates of return for new irrigation construction.

2.2 Wasteful Use of Existing Water Supplies

One of the most challenging issues is to generate water savings from present agricultural, household, and industrial water uses. Water use efficiency of irrigation farming in most regions of the developing world typically ranges from 25 to 40 %, while in urban water supply systems often 50 % or more can be considered as direct water losses. These inefficiencies seem to imply a potential for huge savings from existing uses of water. The potential savings of water are not as dramatic as they sometimes appear, because some of the water "lost" from systems becomes beneficial elsewhere. However, the scope for water savings from existing uses remains large.

An immensely difficult challenge will be to improve the efficiency of agricultural water use and maintain crop productivity, while allowing at the same time reallocation of water from agricultural to urban, industrial and environmental uses. Irrigated area accounts for nearly two-thirds of world rice and wheat production, so increases in irrigated output per unit of land and water are essential to feed growing populations. At the same time, because of the limited number of cost-effective new sources of water, the rapidly growing municipal and industrial demand for water will need to be met increasingly by water savings within irrigated agriculture, the latter generally withdrawing 80 % of water diverted for use in developing countries.

2.3 Degradation of Irrigated Cropland

The past decade has seen, according to Rosegrant (1995), a significant degradation of existing irrigated cropland. Although data is limited and definitions of affected area vary considerably, estimates of annual global losses of agricultural land due to water logging and salinization range from low figures in the order of 160,000 - 300,000 ha (TOLBA, 1978; BARROW, 1991) to estimates as high as 1.5 million ha (KOVDA, 1983), with most of the water logging and salinization in irrigated croplands of high production potential.

The FAO estimates that half of the world's irrigated areas are threatened by the three "silent enemies" of salinization, alkalinization and water logging. Global accounts of the total area affected by salinity but still in production also vary considerably. El-Ashry (1991), Rhoades (1987), and Kayasseh and Schenk (1989) have come to the conclusion that salinity seriously reduces productivity on 20 to 30 million hectares of irrigated land. Barrow (1991), however, estimates that in the late 1980s roughly 30 to 46 million hectares were in a poor state due to salinization. Thus degradation of irrigated area is a significant and growing problem, increasing further the pressure on today's irrigated production.

Besides water logging and salinization, loss of irrigated area is also due to reservoir siltation, deferred maintenance, watershed degradation, excessive water allocation and well failure.

2.4 Ground Water Depletion

Ground water depletion is another severe problem in irrigated agriculture around the world. Overdrafting or mining ground water at a rate higher than the recharge not only increases pumping lifts and costs due to the lowered water table, it also causes land to subside and induces saline water intrusion along coast lines, in addition to other degradations of water quality in the aquifer.

In the United States the equivalent of 4 million hectares, one-fifth of the irrigated area, is irrigated by pumping in excess of ground water recharge (POSTEL, 1993). The Ogallala aquifer, which stretches from South Dakota to Northwest Texas, has been heavily depleted in its southern portions, where ground water supplies dropped from 550 million acre-feet prior to large-scale irrigation development down to 417 million acre-feet in 1990.

In parts of the North China Plain ground water levels are falling by as much as one meter per year, and heavy pumping in portions of the southern Indian state Tamil Nadu has been estimated to lower water levels by as much as 25 - 30 m in a decade. In India's western state of Gujarat, over-pumping in the coastal areas has caused saltwater to invade the aquifer, contaminating village drinking water supplies (POSTEL, 1993).

Fossil aquifers, which are typically deep underground receiving little or no recharge, are being utilised for irrigation in some of the most arid regions of the world. Pumping of fossil water constitutes water mining, one-time extractions from a depletable reserve. Egypt and Libya provide examples of extensive use of fossil water for irrigation. Three-fourths of Saudi Arabia's water supply come from non-renewable ground water sources, and this share is expected to rise: Ground water pumping in Saudi Arabia exceeds estimated recharge more than five-fold.

2.5 Pollution, Water Quality and Human Health

Pollution of water from industrial effluents, poorly treated or untreated domestic and industrial sewage, seepage of agricultural chemicals, and runoff of mining wastes is a growing problem around the world. The main contaminants found in water include detergents (soap and solvents) all kinds of biocides, petroleum and other derivatives, toxic metals, radioactive wastes, fertilisers and other plant nutrients, oxygen-depleting compounds, and vectors of diseases like hepatitis, typhoid fever, cholera, and dysentery (ANTON, 1993).

Because of water scarcity contaminated waste water is very often used for irrigation, creating significant risks for human health and well-being.

2.6 Massive Subsidies and Distorting Incentives

Rosegrant (1995) points out, that despite these challenges, most of the world does not treat water as the scarce resource that it is. Both urban and rural water users are provided with massive subsidies on water use. Irrigation water is essentially unpriced.

In urban areas the price of water does not cover the cost of delivery. Decisions on capital investment in the water sector are carried out irrespective of the management of the resource. In Jordan, despite severe water scarcity, present water policies lead to an overuse of water, often resulting in unpredictable rationing. Excessive use of irrigation water is encouraged by massive subsidies. Irrigation water allocated by the public sector is priced at only one-tenth of the actual cost of water provided by the private sector (ROSEGRANT, GAZMURI, and YADAV, 1995). Annual irrigation subsidies are estimated at US$ 0.6 billion in Pakistan, US$ 1.2 billion in India, and US$ 5.0 billion in Egypt.

Whenever water is provided at little or no cost to the user, neither water managers, irrigation farmers, nor urban water consumers have an incentive to conserve water. As a result, this precious resource is deemed undepletable and is applied excessively for all kinds of purposes, leading to water logging, salinization, ground water over-drafting, and return flows degraded by agricultural chemicals and industrial pollutants. In irrigation farming this could cause a weakening of "best management practices", seriously affecting the profitability of the whole enterprise in the long run.

2.7 Management and Institutional Situation

The management of irrigation systems in many developing countries is characterised by a situation in which the "Irrigation Departments" - isolated from the beneficiaries - make the system run as well as possible with little regard to the basic objectives of crop production. For example, Pakistan's irrigated agricultural sector experiences constraints which, according to its National Commission on Sustainable Irrigated Agriculture, are caused mainly by the following three factors:

(1) a general shortage of good quality canal water, which becomes more pronounced during peak periods of crop water requirement;

(2) a maintenance-related deterioration of the physical condition of the canal system, which reduces the water delivery efficiency while aggravating the water shortage situation; and

(3) a centralised and rather static administrative system, which cannot fully cope with the increasing difficulties of effecting both proper operation and maintenance of the physical system, as well as equitable water distribution.

In Pakistan, as in many other developing countries, these constraints are further aggravated by some daunting environmental problems associated with water logging, soil salinity and flow limitations of the conveyance system. The combined effect of these problems amounts to an increasing inequity and declining productivity in irrigation farming. It is clear that, under conditions of resource shortages, equity and productivity are positively correlated.

2.8 Irrigation Technology

The employment of new irrigation technology in developing countries is a perplexing issue. Theory tells us that new technologies improve the productivity of an economic enterprise and reduce its cost. Yet while there have been dramatic changes in irrigation technology in Australia, North America and Europe in the past 35 years, little of this development affected, for instance, Asian irrigation. Technology employed in many recently constructed canal irrigation systems in Asia would be perfectly recognisable to a turn-of-the-century irrigation engineer. Swendsen and Rosegrant (1994) see a principal reason for this lack of technology transfer in the fact that the most important developments in irrigation technology have occurred in the area of water application and not in the area of conveyance and distribution.

In developing countries, especially in Asia where farms and, often, irrigation schemes are far smaller than Australian or U.S. farms, there has been little adoption of the sprinkler and drip technologies which are the principal targets of research attention. In Asia up to now, most needed are improved technologies for water conveyance, delivery and allocation, and not for water application in the field. This requires, according to Swendsen and Rosegrant (1994), a type of research which is vastly different from the agronomy-related research models that have been introduced to the Asian region from abroad. Such new models must be developed, for instance, in Asia involving close linkages between technology assessment and adaptation and system management innovation. In addition, widespread acceptance of new technologies at the main system level requires a more sweeping sectoral policy and institutional change before strong effective demand for them will emerge.

3 Forces for Change

3.1 The Realistic Approach

In considering the near-term future, trends can be extrapolated to provide a sense of anticipated conditions. But extrapolations are far less reliable when dealing with the mid-range and long-term future. In the case of irrigation development, it is useful to identify and examine fundamental forces and to speculate on their implications for change. Svendsen and Rosegrant (1994) have identified four such forces: Competition for water, environmental concerns, (irrigation) technology, economic and political liberalisation.

3.11 Competition for Water

Water is a finite but renewable resource. What we are concerned with is the timely allocation of the average quantity of fresh water which will be replaced annually in the surface waters and aquifers of a country or region. As we close on the limit imposed by the level of annual replacement, we expect an increasing competition among various

water users and costs of exploitation to rise, as already has taken place in respect to the real capital costs for construction of new irrigation systems (see above).

Irrigation creates typically the largest consumptive use of water, but unfortunately its priority of claiming water is always lower than domestic use claims, and its economic productivity does not compare with industrial water uses. Therefore, according to Svendsen and Rosegrant (1994) irrigation will be subject to increasing pressure in order to reduce its consumption, release supplies for competing uses and pay the economic scarcity cost for water, rather than the current highly subsidised prices.

3.12 Irrigation Technology

The crucial components of an irrigation system - the operational items - are the structures for regulating, diverting and measuring the flow of water in the various parts of the system. Their type and characteristics largely determine the operability and, subsequently, the manageability of the system. There is a great variety of structures available from simple overflow structures to automatically controlled systems. During the last decades, advances have been made mainly in terms of automation. The application of these devices in the water supply part of an irrigation system provides more flexibility in water management and transforms irrigation management from system down to farm level.

In the developing world a relatively slow growing agricultural population has to feed an exploding number of people, especially citizens of urban and periurban areas. Therefore, the output of the agricultural labour force has to be increased by the introduction of appropriate technologies, including irrigation technologies which save labour and ease the workload of irrigation. Under no circumstances shall irrigated agriculture any longer be looked upon as having the capacity to absorb all the unemployed masses of people for whom the national system is unable to provide enough employment in other sectors of the economy.

Consumer-oriented production in agriculture is gaining widespread acceptance, forcing farmers to become even more cost and profit concerned managers. The need to increase the agricultural output and to reduce labour, management and resource input expenses will result in a shift towards the development and use of more sophisticated production technologies even in developing countries.

3.13 Environmental Concerns

Several kinds of environmental issues are of direct concern to irrigated agriculture world-wide. There are affects such as watershed deforestation and so-called externalities which result from irrigation or are exacerbated by it, such as rising water tables, salinization of irrigated land, or chemical contamination of ground water. Irrigation development can also be hazardous to public health by providing ideal conditions for malaria and bilharzia, especially where cropping is envisaged all the year round. Today, however, there are techniques available, that can create disease-free

environments in irrigation schemes or minimise the problems (FEYEN and BADJI, 1993). But the public in many countries becomes increasingly concerned and therefore quite often is opposing irrigation development in general.

Values placed upon various uses of water are changing according to society's preferences. The increasingly urbanised world will demand water not only for new municipal and industrial uses but also for environmental reasons. The public in the industrial countries as well as in the developing world appreciates much more than in the past the value of free flowing rivers, undammed canyons and wetland biotopes. The demand to preserve them will intensify world-wide.

3.14 Economic Liberalisation

Of the forces for change currently at large in the developing world, according to Svendsen and Rosegrant (1994), none is more significant than "economic liberalisation". Recent changes in economic and political philosophy and policy in Eastern Europe, the former Soviet Union, South Asia and in most of Africa are profound and will shape the course of economic and political development in these countries for decades to come. Although applied in different forms in different countries, economic liberalisation is characterised by market-oriented economic policies, realistic exchange rates, liberalisation of international trade, a central role of private initiative in producing goods and services, reduction of subsidies, and transparency in economic policy instruments, i.e. overt rather than hidden subsidisation and taxation. Continued economic liberalisation will improve in many cases the relative competitive position of agriculture in the economy. However, liberalisation also implies reduction of indirect subsidies to agriculture, exerting further pressure for increasing the efficiency of irrigation and raising agricultural productivity.

Dramatic changes have taken place in Eastern Europe. A well documented example is East Germany: With the re-unification of Germany the economical situation in the eastern part of the country has changed completely. For instance the economics of irrigating fodder crops and cereals, which are the main crops irrigated besides sugar beets and potatoes, became questionable. Following re-unification the irrigated area declined dramatically from more than 520,000 hectares to less than 130,000 hectares today. Similar developments took place in other parts of Eastern Europe. Centrally planned economics had installed a farming system, which rearranged the countryside by creating very large field plots, providing good opportunities for the use of large-scale sprinkler irrigation technologies, like side-roll, center pivot and linear move systems. Now the machinery lies idle along the roadside. resembling little more than scrap. Due to the tense economic situation in this region nobody even dares to speculate about the time-frame for new investments in irrigation equipment.

3.15 Administrative Liberalisation?

Environmental concern is a state of mind not easy to reach. When one considers how long it has taken the average citizen in the developed world to adopt at least some essential environmentally sound behaviour, it is hardly surprising that the average politician, who is always trying to find a compromise **between** diverging interests, will need even more time to take account of environmental concerns when making policy decisions. One reason has been his simplistic view of the world, where free trade and continuous growth are the central issues to be dealt with exclusively. Therefore, in the past political systems and their administration have served predominantly the economic sector, smoothing business operations and providing the grounds for the highest possible gross national product, since the latter is deemed the most important performance indicator. Unfortunately, this distorted view of a nation's economic power tends to exclude other key variables of human survival and success from consideration. In particular, the strong belief that the stochastic nature of an unhampered production and trade automatically carries the potential of regulating itself always towards more perfection prevents many a contemporary politician from taking a closer look at the fragile nature of our present well-being. Concern over the negative ecological side-effects of economic development and progress is only slowly making itself felt.

In the future, politicians and government officials - no matter who and where they are - have to operate on a higher level of **social competence**. They are elected and put in charge as leaders and public service personnel, who are obliged to transform society's ideas for a better future. Sustainability is one of the keywords which sets the standards for the international community as a whole. Svendsen (1987) has identified human institutions - a term which covers not only governmental agencies but all sorts of social structures - as "the keys to sustainability". In his words, no piece of infrastructure is stable or sustainable without instructions to operate, repair, adapt and maintain it. This might require unpopular decisions and the will to accept the limits of growth as set forth, for example, by the Club of Rome, especially when reductions in wealth, income and living conditions become inevitable. Unfortunately, this new era does not suit individuals who wish to please everybody with a compromise, but rather those whose integrity allows for clear decisions and prompt execution. However, to invite business oriented characters to venture into typically governmental services, e.g. waste recycling or water delivery, with a profit maximizing philosophy could generate the wrong effects, as demonstrated by many negative examples in Europe and North America.

Administrative tasks like environmental protection and water policies can only be performed right by goverment initiative. More than ever it will be the duty of the knowledgeable and incorruptible official to create and enforce the appropriate regulations.

As far as irrigated agriculture is concerned, there are three major points of interest: To protect **water quality** is an objective which goes beyond agricultural issues and involves both the individual and governmental supervision. But ensuring sufficient **water quantities** for future generations lies solely in the hands of public authorities. In

many cases only painful withdrawal-quota and water rationing will help to solve existing problems. In the past maintaining and improving the **quality of land** has been the responsibility of the land owner. Due to bad irrigation practice, salinization threatens one of the most valuable resources - arable land. At this point, officials truely should think about new regulations which drastically limit the freedom of the private irrigator: The range of possible solutions stretches from demanding an annual "land degradation mortgage" paid by the irrigator, if regular soil probing reveals increasing salinization, to carrying out all water applications in the field by public service, leaving no option to the land owner. The final choice would be to prohibit irrigating at all, forcing the land owner to convert his formerly irrigated fields to dryland farming. On the other hand, large-scale waterlogging could sometimes be attributed to bad planning and supervision by governmental agencies or public services, entitling the private land owner to claim compensation from the authority.

3.2 A Social Fiction Approach - Changing the Global Production System

Ian Carruthers, an internationally recognized well known agricultural economist formerly at Wye College, University of London, forecasts a switch in the global production base which will lead to the cities of the South (developing countries) producing the bulk of the manufactured goods (industrial and others) and services (routine banking, insurance, travel, software development, etc.), while the North (developed countries, incl. Australia) supplying the bulk of their food. Local food supplies will increasingly fail to satisfy southern urban demand because the population of the cities will continue to grow rapidly. Expansion of the area cropped has virtually come to an end; yield increases now depend mainly on institutional reform and management improvement which will be much more difficult to achieve than with new wheat and rice varieties and nitrogen fertilisers as that achieved during the green revolution. Public and private agricultural research in both the North and the South, he argues, will continue to receive diminishing resources, and new biotechnology appears to stumble along with only few practical innovations facing growing consumer resistance. All in all, in his opinion, the prospects for a second phase of the green revolution are remote. He is convinced that the tropical and subtropical developing world will, in about 20 years time, produce the bulk of the manufactured goods, and the temperate world will produce the bulk of the food (CARRUTHERS and MORRISON, 1994).

Carruthers and Morrison (1994) conclude *inter alia:*

(1) "Water problems are central to agriculture's difficulties. Rainfall is inadequate and highly variable. Yet a vibrant agriculture is essential, and, under the assumption of a favourable macroeconomic policy, as land becomes scarcer, technological change in favour of some forms of land and water saving, labour using technology, appears to be the key."

(2) "At present, irrigated agriculture provides one third of the world's food production. Perhaps two thirds of the future incremental production will come from irrigated land.

However, we do not anticipate or call for an increased rate of capital intensive investment in irrigation infrastructure but we do need to see more achieved with what is presently developed."

(3) "It is thus conceivable that in the next decades we will see increasing incentives for the North's food producers to increase production (perhaps with less subsidy), given that an increasingly urbanized and industrialized South will be in a position to pay for these imports."

What an outlook, indeed - a Morgenthau-Plan for the humid, temperate zones of the earth! Unfortunately, it will only delay the problems of water mining and pollution for a few decades or so, resulting in even worse conditions. And what will happen if social unrest and political conflicts with possible military action arise in such a global setting of division of labour and production means? It will surely mean the end of the world ...

4 Conclusions and Questions

The future needs more than today's professionalism in drawing up new ideas and relief plans. It requires - as simple as it sounds - true decisive action in solving all those problems already identified; it cannot afford to delay taking such action.

Projections of future irrigation development over the next half century are exercises in "futurology". But the following is not speculation: Irrigated agriculture around the world, and especially in developing countries, faces extraordinary challenges in the coming decades. On the one hand, it has to provide a major share of the required increases in food and fibre production to meet the objectives of poverty alleviation and development. On the other hand, it is threatened by water shortages arising from accelerated competition of domestic, industrial and other water users. This situation is further worsened by dwindling financial resources available for capital expenditures as the costs of new irrigation schemes increase.

In the future, municipal water demand will always be of first priority. It becomes quite clear that world wide a reallocation of water supplies will have to take place. In many cases there will be a transformation of irrigation water sources in favour of domestic and industrial uses. Agriculture and especially the irrigation sector, being at present the main water user, will have to get along with less and less water in the years to come - water that could be increasingly of marginal quality.

However, developing countries are beginning to follow western production philosophies, shifting from land-extensive farming to land-intensive agriculture, well aware that they will in future be dependent on external inputs and on the introduction of cost reducing technologies. But future increases in output will be gained from the same resources, placing an even greater emphasis on yield increases. The critical question which remains un-answered is: Can technology continue to generate the yield increases required in the future? This question is further complicated by concerns about the sustainability of agricultural development in the Third World, the shortage of

unoccupied and suitable land, and the availability of adequate water supplies to meet projected future requirements.

The mechanism of poverty and overpopulation is well understood and documented. Nevertheless, we have not been able to adjust the number of people to the population supporting capacity of the land in those regions of the world which are most prone to famine and resource misuse. Technical and economical instruments, like irrigation development and subsidy, have not brought any relief of the tense situation in these often resource lacking, marginal areas, because such measures generate too small an advantage per capita in the long run; in addition, they fail to provide equal opportunities within and among supported regions due to the pronounced variable nature of ecosystems. This causes the "poor guy" to react as always, securing his well-being by a greater number of descendants. Therefore, if we do not want to exert pressure, our only chance is to provide every individual with an outlook for a sustained fair income in order to change his reproduction habit. **But how?** The answer might well be a prize-winning one.

5 Summary

Irrigated farming performs an essential task in meeting the basic food needs of billions of people in the world. In the future, the irrigated sector will have to provide an even larger proportion of total food supplies. But country-wide, regional and seasonal water scarcity in developing countries poses severe problems for national governments and the international development community. The challenges of growing water scarcity are exacerbated by the increasing costs of new water, wasteful use of already developed water supplies, degradation of soils in irrigated areas, depletion of ground water, pollution of water and its impact on human health, and the massive subsidies and distorting incentives which govern water use.

Fundamental forces and their implications for change are identified: competition for water, environmental concerns, irrigation technology, economic and political liberalisation. The paper comes to the conclusion that the future needs more than today's professionalism in drawing up new ideas and relief plans. It requires true decisive action in solving all those problems already identified; it cannot afford to delay taking such action.

Bewässerung in der Welt - die Zukunft wird nicht wie die Vergangenheit sein

Zusammenfassung

Der Bewässerungssektor gewährt die Nahrungsmittelversorgung und Ernährungssicherung von Milliarden Menschen. In Zukunft wird die Bewässerungslandwirtschaft einen noch weitaus größeren Teil der Nahrungsmittelversorgung sicherstellen müssen. Die landesweite, regionale oder saisonale Wasserverknappheit in den Entwicklungsländern stellt die Regierungen wie auch die internationale Gebergemeinschaft vor große Probleme. Die Herausforderungen der zunehmenden Wasserknappheit werden verstärkt durch die steigenden Wassererschließungskosten,

die weitverbreitete Wasserverschwendung, die Degradation der Böden in den Bewässerungsgebieten, die Erschöpfung der Grundwasservorräte, die Verschmutzung der Wasservorkommen und die massiven Subventionierungen, die die Wassernutzung bestimmen.

Die Arbeit macht deutlich, daß der künftige Umgang mit der Ressource Wasser durch grundsätzliche Veränderungen bestimmt wird, dieses sind u. a. die Konkurrenz um das Wasser, Umweltschutzbedenken, Fortschritte in der Bewässerungstechnologie und die ökonomische wie auch die politische Liberalisierung. Die Arbeit kommt zu der Schlußfolgerung, daß zur Meisterung der Zukunft mehr erforderlich ist als die derzeitige Professionalität in Entwicklung neuer Ideen und in der Erstellung von Entlastungsplänen. Es sind wirkliche, gezielte Aktionen zur Lösung der anstehenden Probleme notwendig, Problemlösungen, die keinerlei Verzögerungen zulassen.

Riego en el mundo - el futuro no será como el pasado

Resumen

El sector de riego permite la disponibilidad y seguridad de alimentos básicos a millones de personas. En el futuro la agricultura de riego tendrá que proveer aún más una gran parte de la disponibilidad de alimentos. La escasez de agua a nivel nacional, regional o periódica representa para los gobiernos de los países en desarrollo, así como para la comunidad internacional de ayuda al desarrollo un gran problema. Los retos de la escasez de agua cada vez más creciente se refuerzan por los aumentos de los costos de nuevas instalaciones, el mal uso generalizado del agua, la degradación de los suelos en las regiones de riego, el agotamiento de las reservas de aguas subterráneas, la ensuciamiento de las fuentes de agua y los subsidios masivos que determinan el uso del agua.

El trabajo deja claro, que el futuro manejo del recurso agua debe de ser determinado por cambios sustanciales tales como: la competencia por el agua, la consciencia medioambientalista, progresos en las tecnologías de riego y la liberación tanto económica como política. El trabajo llega a la conclusión, que el diseño del futuro es más necesario que la profesionalización actual en el desarrollo de nuevas ideas y en la elaboración de planes de ayuda. Estas son acciones necesarias y verdaderamente dirigidas para la solución de los problemas identificados. Estas soluciones no pueden esperar más.

L'irrigation dans le monde - l'avenir ne ressemblera pas au passé

Résumé

Le secteur d'irrigation assure l'approvisionnement en nourriture de milliards d'êtres humains. Dans l'avenir, l'agriculture irriguée devra assurer une des plus grosses parties de l'approvisionnement en matières nutritives. Le manque d'eau au niveau national, régional ou saisonnal dans les pays en voie de développement représente un probléme très grave pour les gouvernements et les organismes d'aide internationale. Les conséquences entrainées par la pénurie d'eau sont agravées par la hausse du coût d'accès aux réseaux d'approvionnement, par le gaspillage d'eau, par la dégradation des

sols dans les zones irriguées, par la diminution du niveau des nappes souterraines, par la pollution des sources et par le subventionnement massif qui déterminent le mode d'utlisation de l'eau.

Ce dossier explique que dans l'avenir, les êtres humains devront effectuer un changement de comportement radical vis à vis de l'utilisation des ressources en eau. Il y aura entre autres plus de concurrence avec le droit d'utilisation de l'eau, il faudra plus de conscience pour la protection de l'environemment, des progrès dans la technologie d'irrigation et une libéralisation économique et politique. Le dossier mène à la conclusion qu'il faudra surtout développer de nouvelles idées et des plans de délestage, plutôt que la professionalité d'aujourd'hui, ce sont des actions précises qui visent à résoudre les problèmes qui se posent et dont les solutions ne peuvent attendre, dont nous aurons besoin.

6 Literature

1. ANTON, D., 1993: Thirsty cities - Urban environments and water supply in Latin America.- International Development Research Center, Ontario (Canada).
2. BARROW, C.J., 1991: Land degradation: development and breakdown of terrestrial environments.- Cambridge University Press, Cambridge.
3. CARRUTHERS, I.; MORRISON, J., 1994: 2020 Vision - Dramatic changes in the world agricultural and industrial production systems.- IIMI Review Vol. 8 (No. 1), 14 - 20.
4. EL-ASHRY, M. T., 1991: Policies for Water Resource Management in Semi-Arid Regions. - International Journal of Water Resources Development 7 (4), 230 - 236.
5. FAO-Food and Agricultural Organization, 1992: Water for sustainable food production and rual development - UNCED agenda: targets and cost estimates. - FAO, Rome (Italy).
6. FEYEN, J. and M. BADJI, 1993: Environmental and health aspects of irrigation.- Zeitschrift für Bewässerungswirtschaft 28 (H. 1), 6 - 30.
7. KAYASSEH, M. and C. SCHENK, 1989: Reclamation of Saline Soils Using Calcium Sulphate from the Titanium in Industry. - Ambio 18 (2), 124 - 127.
8. KOVDA, V.A., 1983: Loss of Productive Land due to Salinization. - Ambio 12 (2), 91 - 93.
9. POSTEL, S., 1993: Water and Agriculture. In: Gleick, P.H. (Editor), 1993, Water in Crisis A Guide to the World's Fresh Water Resources. - Oxford University Press, New York.
10. RHOADES, J. D., 1987: The Problem of Salt in Agriculture. - Yearbook of Science and the Future. Encyclopaedia Britannia, Chicago.
11. ROSEGRANT, M., 1995: Water resources in the 21st century: increasing scarcity, declining quality, implications for action.- Paper presented at the Conference on the Sustainable Future of the Global System (Tokyo), organized by the United Nations University and the National Institute for Environmental Studies, Japan.
12. SVENDSEN, M., 1987: Sustainability in irrigated agriculture. - Working Paper No. 4, IIMI, Colombo (Sri Lanka)
13. SVENDSEN, M. and M. ROSEGRANT, 1994: Will the future be like the past? In: Heim, F. and Ch. L. Abernethy, 1994: Irrigated Agriculture in Southeast Asia beyond 2000.- German Foundation of International Development (DSE), Feldafing (Germany) and International Irrigation Management Institute (IIMI), Colombo (Sri Lanka).
14. TOLBA, M. K., 1978: Welcome Adress. Proceedings of Water Management for Arid Lands in Development Countries Workshop, Volume 13. Pergamon Press, Oxford.
15. YUDELMAN, M., 1994: Demand and supply of foodstuffs up to 2050 with special reference to Irrigation.- IIMI Review Vol. 8 (No. 1), 4 - 14.