

Sustainability of Irrigation Systems **Nachhaltigkeit von Bewässerungssystemen**

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1. Sustainability Concept

Sustainability is much discussed nowadays as a goal of rural development policies. By itself, the word does not mean much; or rather, its meaning is vague and different people understand it in different ways.

To clarify it, we must first give it an object. That is, we must say what it is that needs to be sustained. We can aim for sustainable resource use, or sustainable agriculture, or sustainable growth rates, and so on. These are very different objectives, and lead us to different policies.

There are people who assign high priority to sustaining aspects of the natural environment, such as bio-diversity. This approximates to the conservationist attitude. Others want primarily to sustain certain sorts of human interventions in that environment, such as agricultural and irrigation systems. This approximates to the development attitude.

The concept of "sustainable development" is an integrating idea, and a bridge between conservation and development. It recognizes that development can be damaging; but also that in the current context of population growth and rising human goals, development must happen, and must prosper.

So the quest for sustainable development means identifying types and intensities of development, and corresponding modes and levels of operation and management, that seem capable of being continued for as far as we can see into the future without significant diminution of their benefits and without causing significant harm to others.

Here, we shall try to apply these principles to the Sustainability of irrigation systems.

2. Sustaining which Attributes of Irrigation Systems?

Just to say that we fell interested in sustaining irrigation systems may not be quite enough. Various attributes could be considered as objects for sustaining, such **as**:

- Irrigation facilities
- Production potential
- Operational performance
- Irrigated agriculture

Some of these do not seem appropriate objectives. Sustaining the facilities is not enough, unless people are continuing to use them. Insufficient utilization of available facilities is occurring in a number of countries. The "land abandonment",? phenomenon in Malaysian irrigation is a case. Conversely, sustaining output performance could be an unsuitable goal if (for whatever reason) demand for the crop product weakens. A factory that produces greatly in excess of demand (for example, the European or North American steel industries in the 1980's) faces severe sustainability problems. There can be circumstances where a reduction of output is a condition for improving sustainability.

I propose therefore that we take the management objective to be the sustaining of irrigation systems as functioning enterprises. Then, when we speak of "sustainability", as a kind of shorthand or keyword in the irrigation management context, we are meaning the search for some set of policies and practices under which we will feel confident that the system should continue to exist and to function, at least for the sort of time-span (say 20 or 30 years) that constitutes a horizon for this kind of prediction.

Tighter definition than this is not appropriate. The value of the sustainability idea is conceptual. It gives us an attitude and an orientation. But the idea is inherently qualitative, and (since it refers to the future) imprecise. Attempts to define it too exactly could reduce its attitude-forming value, without gaining anything much.

3. Changes of Sustainability

Sustainability is not a physical property. It is a concept that relates the physical artefacts of development with the socio-economic and biological environments in which they are placed. As these environments can change, so sustainability can change.

In North Yemen there are immense terrace systems reputedly centuries old; that is, they have been proved to be a sustainable system. The economic attractions of employment in oil-producing countries depleted the labor resource formerly available for their maintenance, and many collapses occurred. A socio-economic external change altered the system's sustainability.

Such examples show that in changing times, sustainability of operational practices should not be taken for granted, but should be kept under review. We cannot inspect a particular irrigation system, or a particular management method, and simply declare, "yes, that is sustainable". The external context may change in some adverse way (or in some positive way) that will modify our estimate of sustainability. We must always be vigilant, and try to ensure that management responds flexibly to any threatening external changes.

Any statement about sustainability is simply an opinion about what is going to happen in the future. Our opinions about the future are likely to be better if they are supported by sound data about what is happening in the present, and has happened in the recent past. From such a data-base, managers may get early warnings of changes or trends that may indicate weakness of sustainability.

3. Institutions

Svendsen (1987) has made the essential identification of human institutions as "the keys to sustainability". He says "over a period of... a few seasons, no piece of infrastructure is stable or sustainable without instructions to operate, repair, adapt and maintain it".

This point is quite vital in respect of irrigation systems, yet it is by no means always incorporated into writings about sustainability. It illuminates the preceding point about changes in sustainability.

It emphasizes that, when we try to determine whether a specific system possesses sustainability, we must determine the health of its institutions: their finances, their energy, their incentives, their objectives.

"Institutions" does not just mean government agencies. It can mean all sorts of social structures. If these decay or are by-passed, sustainability changes. There have been numerous reported cases of systems, initially managed and sustained by farmers, which, after take-over by government, lost sustainability.

4. Wider Context

Irrigation systems do not exist in isolation but as parts of various larger systems: regional rural development systems, ecological systems, national food production systems, and so forth. They will be more likely to be sustainable if they conform well to these larger system environments and do not develop incompatible goals.

There are well-known recent cases (in Florida and California and many others) where changes in chemistry, quantity or timing of effluent water of irrigation systems have caused unacceptable biological effects downstream; so that the practices causing these results were not sustainable.

There are also converse examples (from North China, for example) where the introduction of irrigation has raised the population-supporting capacity of valley-bottom land and so has facilitated re-settlement of people away from steep, eroding land; in such cases, irrigation is increasing the sustainability of a more complex system.

5. Threats

The idea that we need to sustain the performance of an irrigation system implies that there are opposing forces which would otherwise threaten to bring it down. Identifying these threats should be the key to various protective actions by managements.

We can categorize some of the major sources of these threats:

Physical	Siltation
	Water-logging
	Salinization
	Loss of fertility
	Natural catastrophes (typhoons, droughts, etc.)
Socio/economic	Institutional weakness
	Economic competition
	Competition for resources
	Water-related diseases
	Labor deficiency

Financial	Operating costs Inadequate funding mechanisms (fee collection, etc.) Inadequate incentives (markets for the outputs: salaries for the operating staff)
Biological/environmental	Weed growth Effluent pollution Downstream hydrologic changes
Political	Adverse policy environment Goal incompatibilities

6. Impacts

These various threats do not all affect the performance of irrigation systems in similar ways. It is useful to classify also the kinds of impacts that irrigation systems may suffer, and that may cause unsustainability. There seem to be three major ways in which this can happen:

- i Systems may lose sustainability because they are no longer able to deliver their benefits.

An example of this kind of impact is when an irrigation supply reservoir becomes silted up and its water-storage capacity is reduced. Eventually, it becomes impossible to supply the dependent command area with water.

- ii System may lose sustainability because, although they are performing well internally, they are injuring other interests.

This category includes various environmental problems, such as cases where the outflow of drainage water from irrigation systems has changed the water environment downstream; for example, reducing the salinity of coastal lagoons and thus damaging the habitats of species living in or using those lagoons.

- iii Systems may lose sustainability **because people no longer want to devote** necessary efforts to key activities.

In very poor countries most people do not have economic alternatives to the agricultural life; but as countries reduce their poverty problems the range of

economic alternatives for individuals increases. Then they will not continue to participate in irrigated agriculture if its rewards are small (in comparison to other possibilities). This sort of unsustainability is now apparent in several middle-income countries.

7. Resilience

The resilience of a system is the rate at which its performance can recover after an adverse event. Resilience is especially desirable in environments where threats are numerous or frequent; for example in the Philippines where natural catastrophes are common.

Systems will usually be more resilient to some kinds of threat than to others. Traditional systems may be more resilient than modern designs, if they have evolved specific responses to cope with the threats that are most often experienced in their environments.

Diversity is a factor that gives resilience to a system: especially diversity of crops, and diversity of activities. The latter expression means the incorporation of economic activities other than cropping, such as livestock, fish, forestry. Monocrop systems may show lower resilience.

8. Performance and Sustainability

We know that there must be an intimate linkage between an irrigation system's sustainability and the various aspects of its performance. We have noted that Sustainability requires healthy institutions. Unless there is a level of performance that is at least maintained with sufficient consistency, or (more desirably) increases steadily, this condition will probably not be met.

On the other hand, performance (at least those performance indicators which denote crop output) should be conditioned by the level of effective demand for the product. This will fluctuate. A level of performance that would result in output substantially exceeding effective demand, is quite likely to be found unsustainable. It may lead to demands for subsidizing actions or market distortions by government; but many countries have found that these actions are difficult to sustain indefinitely.

Since externalities (world markets, other producers, nearness of processing plants, etc.) determine demand, whereas internal organizational actions try to influence performance, the possibility of incompatibilities is evident.

In developing programs to enhance performance, we should take heed of the role of effective demand, and note that growth of output, at a greater rate than growth of effective demand, must create sustainability problems.

9. Sustainability Levels

A system that is not sustainable at some given level of activity, could prove sustainable under some different (higher or lower) intensity of activity, if revenues do not exceed costs, for example, this is an unsustainable situation, but it might be found possible to sustain the system by dropping to some lower output performance level where the revenue/cost relation is better. To some extent, the wave of farmer-participation projects may include adjustments of this kind.

10. Scarcity of Resources

Sustainability can only be achieved if the resources that are necessary for the conduct of irrigated agriculture will continue to be available. At present, in the aftermath of the Rio de Janeiro "Earth Summit" meeting, much attention is focussed on the increasing competition for water resources, but water is not the only essential resource. Indeed, water is a renewable resource, whereas land is not.

The major resources that must be assembled and maintained are water, land, labour, energy and finance. In a strict sense, the last of these is not a resource but a means for obtaining other resources, however, from a manager's viewpoint it is just as necessary as the others, and its absence would mean that essential functions are not performed. As the movements towards privatization and commercialization of irrigation increase, cases of unsustainability due to financial deficits are more likely to be encountered.

Many examples of unsustainability due to resource competition can be found. Transfer of land and soils to urbanization, or urban-related activities (such as brick-making in Egypt); abandonment of irrigation facilities by farmers in Malaysia; insufficiency of electricity supplies to keep ground-water pumps operating in North

India: all of these are cases where irrigated agriculture is not able to compete successfully for all the resources it requires. On the other hand there are cases where, some people consider, irrigation development was pursued too enthusiastically in the past and captured a large share of water resources, some part of which may now have to be transferred to satisfy other objectives: examples include the depletion of water from the Aral Sea, and the increasing constraints due to water scarcity in the south-western United States.

11. Monitoring

The most difficult question, in regard to sustainability, is how to determine whether a particular system has, or has not, got this desired feature.

We need monitoring systems that will give us early warning of conditions that may lead to system deterioration or collapse.

From the preceding arguments, it seems that such monitoring arrangements should concentrate on:

- a. Specific indicators of performance, especially outputs, net economic returns to farmers, input utilization parameters such as crop intensity, and net budgetary costs to managing agencies. These have to be measured continuously and in a consistent manner, because sustainability depends not on single values but on rates of change over years.
- b. Indicators of threats, such as those outlined earlier. System managements need to make choices as to which items carry greatest risks to their specific systems.
- c. Indicators of institutional strength. Policy-makers need to develop indicators that will show whether the capabilities of the relevant institutions and organizations are weakening. There have been various such studies on farmers' organizations; but probably more important at present is the effectiveness of governmental and parastatal institutions.
- d. Resilience should also be analysed. This is not so much a question of direct monitoring, as of analysis of the data collected under the preceding categories, in order to see whether systems possess the capacity to recover after adverse events such as droughts, energy cost increases, crop price falls, pest attacks, etc.

12. Summary of Issues for Managers and Policy-Makers

The following is a brief check-list of sustainability issues that need **to be addressed** in practical circumstances:

- a. What is that is to be sustained?
- b. Which threats are most important?
 - Which are most likely?
 - To which is the system most vulnerable/least resilient?
- c. How can we know whether we have achieved sustainability?
- d. How can we monitor sustainability?
- e. How can we evaluate the data providing by monitoring?
- f. What changes or trends are occurring?
 - Within the system
 - Among the external factors that affect the system
- g. What management actions are possible/desirable to enhance sustainability?

Reference

Svendsen, M., 1987: Sustainability in irrigated agriculture. Working paper no. 4, IIMI, Colombo, Sri Lanka.

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