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door prof. L.F. Vincent

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Mijnheer de rector magnificus, dames en heren

For a foreign Professor of Irrigation and Water Engineering, an inaugural speech to a Dutch audience is both a challenge and an opportunity. What can I present to a society so involved with effective water control? Well, it is said that outsiders can help a group to recognise and build on their strengths. They bring not only experience, but also different understanding to extend these strengths. My speech today pays tribute to the Wageningen commitment to promoting sound water management. However, it also presents my ideas for future research and education at Wageningen, built from my own experience in irrigation and development.

For both these objectives, I open my speech with a quotation from an epic of the ancient Sumerians, a hydraulic society which faced some similar challenges to the Netherlands in water management. We know that canals were operating in Mesopotamia from well before 2000 BC (Heathcote, 1983). The Sumerians linked the birth of the Universe with the creation of the Tigris and Euphrates rivers, and the great irrigation works therein (Moore and Lidz, 1994):

Now that the 'fate' of the universe has been decreed,
Dyke and canal have been given proper direction,
The banks of the Tigris and Euphrates have been established,
What else shall we do?
What else shall we create?
(Kramer, 1961, p.122)

Secure in the divine invincibility of their engineering, and prosperity of their agriculture, the Sumerians went on to create several city states, including Babylon, Ur and Sumer, and to build the legendary Tower of Babel (Moore and Lidz, 1994). It led them to create further economic growth through military expansion, including the conquest of Jerusalem.

However, there were several things that the descendants of the Sumerians forgot to create and evolve - a sound system of operational management, and sustainable irrigation practices. Their magnificent irrigation systems suffered progressive environmental decline. There was not only insufficient technical understanding, but also under-investment as resources went elsewhere, and progressive stagnation occurred in the overall adminstration. The lands of the Fertile Crescent were becoming saline before Nebuchadnezzar transported the prophet Daniel, and before the Medes and Persians conquered the Babylonians. War only exacerbated what poor management had already initiated.

Why invoke the Sumerians for this inaugural address at the end of the twentieth century? Well, internationally, irrigation is receiving renewed attention as a critical input to support future world food supplies. Irrigation is also centrally involved in debates about competition for water, better environmental management and the economic viability of irrigated agriculture. Cuts in funding have changed the working environment for irrigation engineers nationally and internationally.

Thus, like the Sumerians, the fate of our world is also decreed in its ongoing dependence on irrigated agriculture and sound water control. The dykes and canals continue to need proper direction, in both a physical and institutional sense. However, this must be done under rapidly changing social and environmental conditions. Irrigation professionals must ensure there actually IS water available to flow in the canals, and work with others to create effective water resource strategies. The lessons of the Sumerians lie not only in the importance of a workable bureaucracy (Wittfogel, 1957). They also lie in the understanding of links between environment and society, as mediated by science and technology.

The experience of the Sumerians also stands as a metaphor for much international irrigation development during this century. Criticisms abound on the bad appliance of science. These include design and construction without commitment to sound operations, and inability to adapt irrigation management to dynamic natural and societal conditions. The story of the Tower of Babel has special resonance for engineers - the application of cutting-edge science to one of the first great public works, only to create incomprehension, mis-communication and lack of cooperation in its wake.

Contemporary engineers recognise the over-ambition of much twentieth century science and technology. They now advocate renewed attention to invention, experience and work with users, in addition to responsible application of science. They also recognise the social dimension in technology. As the floods of

1995 showed in the Netherlands, the 'proper direction' of the dykes involved consideration of environmental and social use, and not just physical engineering. Engineers now want a return to 'systems thinking' about technology, and not just systems analysis (Checkland, 1981; Ferguson, 1993).

Irrigation is still vital for food production: however, there is now a transformation in policy debates for economic development. Three particular concerns are emerging - scarcity, sustainability and security - and irrigation is involved in all three. It is these new pressures on irrigation, and the new realism in engineering, that I make the centre of my speech today.

I feel these are also consistent with another transformation taking place - to the new Kennis Centrum Wageningen. The themes of the new Centre - on ecological agriculture, rural resource management and viable technology - certainly link with these broader international policy concerns. Last but not least, my Chair, like others at Wageningen, has been involved in transformation by reorganization. I took a decision to leave my inaugural address until I was more certain about the field of my post and my leerstoelgroep. Mijnheer de Rector Magnificus, I never thought this would take so long! I want to thank you and your staff for the support given to me during this period.

There are other reasons also for my references to the Sumerians and the Tower of Babel. As a new foreign professor I have struggled to build new programmes

with you, in the face of language difficulties. I am still studying to work in one language where possible in University development. However, my spoken Dutch is still poor, and I hope you will forgive me if I continue this speech in English.

The title of my address begins with the phrase 'Irrigation as a technology, irrigation as a resource.' This title gives an indication of the different ways in which irrigation can be studied, to generate new understanding for today's world. However, the second part of the title is a 'sociotechnical approach to irrigation', giving recognition to the breadth of understanding necessary to create functional irrigation systems (Keller, 1986, 199). Sustainable irrigation practices will never emerge unless we can promote these inter-disciplinary perspectives, and combine scientific knowledge, practical engineering skills and social understanding. This is the only means to design operational systems and support services appropriate to the users of irrigation systems.

The speeches of my predecessor, Emeritus Professor Luc Horst, shows the struggle this inter-disciplinarity has sometimes involved, both intellectually and professionally (Horst, 1976, 1992). Yet he, together with the irrigation group, remained committed to promoting both inter-disciplinarity and practical skills in their students. I am proud to have been invited to join this impressive Dutch tradition, and hope I can carry it forward to meet these new challenges in the twenty-first century.

What is irrigation?

Irrigation presents many challenges in philosophical conception. Irrigation water, flowing to the fields and delivered to the plants, can easily be conceived of as a resource to support plant growth, and transform biomass production. An entire irrigation system can also be treated as a resource, as an investment that gives added value from land and water, or can be used as an agent of social transformation. A resource is something required for the existence of society, but also specifically valued for the contribution it makes to that existence. In capitalist societies, 'natural resources' are raw materials that enable prodcution and accumulation. In other societies, natural resources may be cosmological entities in which human existence is embedded, where use has symbolic meaning or cannot be disassociated from its consequences for the resource entity, as with the water temples of Indonesia (Lansing, 1991). Some researchers consider artefacts and social relations as resources (Bader and Benschop, 1988). Thus there are several 'resource' perspectives on irrigation: these include a natural resource system approach; a societal resource approach; and a farming/livelihood system approach.

However, irrigation water is only available because technologies have been developed to mobilise and control water. Irrigated cultivation involves a range of technological interventions that modify the flows and cycles of a natural ecosystem, to create a new agro-ecosystem. So we can also see irrigation as a technology. There are also different ways to study technology. We can study irrigation as a physical

system, where we focus literally on the physics of engineering - on the dimensions of physical or biological technology, and their impact on natural flows. Where organization is engineered to suit this infrastructure, we can talk about a socio-physical approach to irrigation. We can also study irrigation as technology system (Stewart *et al.*, 1990) integrating components and operating systems that organise inputs, outputs and workforce for production. Finally, we can see technology as a capacity to transform and regulate, through means such as artefacts, labour power, institutions and knowledge.

So is irrigation a technology or a resource, and how is it best studied? Can irrigation be studied as both a technology AND a resource, for better understanding of irrigation practices? This perspective is made possible in the sociotechnical approach to irrigation.

A sociotechnical approach starts from this view of technology as a capacity for transformation and control. It builds on this by looking at the social shaping of technology, through study of the requirements of use and the aim of use, and the knowledge systems and ideas of Nature applied in its invention. Hence the name, a sociotechnical approach. Exploring this transformative capacity enables us to understand how technology becomes viewed as a resource, and the artefacts, processes and other means that make this so. The approach also helps us understand how these means shape the use of natural resources and their transformation. This approach has obvious value in studying the social transformations wrought by irrigation. However, the approach also has

special utility for studying irrigation practices, and processes of design and operations.

I now give a summary of these different approaches to irrigation. I hope a brief overview will help you understand past battles at Wageningen about irrigation, but also pave the way for better future cooperation.

The study of irrigation as a *natural resource system* has been spear-headed by researchers such as Ostrom (1990) and Bromley and Cernea (1989). They see natural resources as a form of capital to which people have access, and irrigation as an investment that intensifies this natural capital and its potential utility. The main focus of this group has been on the institutions and governance mechanisms that mediate access to natural resources. Irrigation is of special interest in the way it requires collective action in development and operation. This approach has made a distinctive contribution to understanding of the institutional dynamics of resource use. However, this knowledge has been gained by treating the technology of irrigation as a black box or 'given', making it weak as a guide for practical intervention. It rarely considers production choices and thus conflicting concerns for livelihood security or profit maximisation. It often utilises game theory in water use, with its assumptions of economic rationality which are disputed by other researchers - irrigators often do act for the greater good of the group. Finally, it is weak on analysis of bureaucracy, which it tends to see as destructive to collective action. It thus cannot show how bureaucrats, farmers and operators influence design, operations and outputs.

Irrigation can also be seen as a *societal resource* (Bader and Benshop, 1988), used in the production and reproduction of inequality, to shape or transform social relations. This new term is only now being formally applied in water resources research, but there is existing irrigation research with a similar orientation (Gelles, 1994; Guillet, 1991). This approach has proved very helpful in studies on competition for water, and forms of negotiation and struggle between farmers. It shows how farmers and social groups can take action to defend or improve their interests in water. However, it often deconstructs technology into various social relations, and thus also gives very little attention to practical change in production and infrastructure. Like the Natural Resource Systems approach, this perspective is also interested in governance and negotiation. However, its approach highlights plurality in governance systems, societal objectives and interest groups, and looks at practical means of mediation between them.

Irrigation has also been studied through a *farming system/rural resource system* perspective. The 'farming systems' approach developed to promote greater attention to the small farmer, and has a strong interest in the resource dynamics of agro-ecosystems. It draws both on the environmental shaping of production and land use options, but also on knowledge systems that shape adaptation and control of resources for agriculture. This approach has contributed a great deal to knowledge about transformation of biomass production and resource flows in agro-ecosystems. Sometimes it has also told us much about farmers knowledge of the local environment and the logic of

farmers practices. However, the supply of irrigation water also often gets treated as a 'given'. All too frequently, researchers in this approach expect irrigation water to be adapted to supply the chosen production system. However, in many locations, farmers are adapting their landscape and production to available water supply and livelihood needs. Unfortunately, the agronomic perspectives on irrigation have become increasingly polarised between different methodological approaches in study of agro-ecology and adaptation of technology. A *farming systems* perspective has become increasingly associated with studies of resource flows within a commodity or enterprise orientation (Shaner *et al.*, 1987). Researchers interested in small-scale and subsistence cultivators, and more marginal environments have now differentiated a *rural resource system* approach that emphasises work with local knowledge and livelihood preferences (Lightfoot *et al.*, 1991).

Within the irrigation profession, many see irrigation as a *socio-physical system* (Small and Svendsen, 1992). As the term suggests, the approach gives strong attention to the physical behaviour of water flow and component technologies involved in the irrigation system. In recent years the study has been broadened to bring more attention to the social organization th· makes a system operational. This approach has generated much of the recent irrigation science no· applied in design. It has also generated many of ' new component technologies and operating syst· claimed to make systems more flexible or effic· draws on the bio-physical modelling of ecolo· also uses quantitative economics, agro-climat

land evaluation to design water allocations and farm budgets. However, it also has several weaknesses, many of which are responsible for current poor performance in irrigation systems. Its reductionist approach leads to compartmentalization of knowledge which can give poor solutions to design dilemmas. The users of systems are usually hidden inside design routines, described crudely through empirical factors that link them to inefficiencies, losses or uncertainties in system behaviour. It also tends to treat 'scarcity' of water as simply a physical dimension of system operation. The separation made between physical and social dimensions of irrigation is considered unreal by other researchers, who also recognise that farmers make many practical changes that often improve irrigation water delivery (Bolding *et al.*, 1995; Manzungu and Van der Zaag, 1996; Wahaj, 1995).

There is also a view of irrigation as a *technology system*. This is helpful at seeing misfits between component technologies, and between equipment and its operating systems: it also gives understanding of how biases emerge in choices of technology and operating systems. One older view of a socio-technical system was that of Uphoff (1989), who looked at the management needs of irrigation technology as two sides of the same coin. However, like the socio-physical system, it cannot tell us WHY systems are designed and operated in certain ways and how these processes and artifacts might be changed.

Since the tenure of Professor Nugteren (1967), irrigation at Wageningen has focused on tertiary level development and management. This gives a special

focus on irrigation practices in managing water and irrigated production, on transformation of these practices, and the interactions between water, crops and people involved (Diemer and Huibers, 1996). It is against this mandate, and the limitations of other approaches, that the irrigation group at Wageningen have developed its *sociotechnical approach*. The group still works with the normal science of irrigation, but uses the approach to critique it, to study field conditions and promote new ideas. One key advantage of the sociotechnical approach is its central focus on technology and thus on practical dimensions of design, operations, management and output. As my predecessor emphasised in his retirement speech (Horst, 1992), research on design and operations is different from fundamental research on the natural environment - but it is essential to the improvement of irrigated agriculture. This emphasis will continue during my tenure. Another utility of the sociotechnical approach is the societal dimension it brings to the study of technical intervention in an ecosystem. It thus avoids simplistic environmental determinism in studies of design, operations and production (Bottrall, 1992; Burns, 1990; Jurriens and Mollinga, 1996, Vincent, 1995). The approach also highlights the importance of practical actions by operators, farmers and front-line bureaucrats who struggle to make a system functional, adding local change to general institutional and techincal arrangements in place. It has tried to conceptualise water scarcity from a societal perspective, in ways that also keep the user linked with options to change water delivery (Jurriens and Mollinga, 1996; Keller, 1986; Merrey and Somaratne, 1989; Uphoff *et al.*, 1990; Vincent, 1998).

A number of specific concepts have been developed for irrigation within a sociotechnical approach. The first was to see irrigation as a *force*, with its associated dimensions of transformation, domination or destruction. Researchers at Wageningen recognised the use of irrigation as a social force for economic transformation (Eggink and Ubels, 1984). They also recognised how irrigation was a bio-physical force impacting on the environment. Sometimes this was negative, bringing salinisation and pollution. However, several groups now recognise that irrigation can have positive impacts, with land husbandry that promotes stability and water management that reduces rates of natural salinisation (Wu and Thornes, 1995; Kielen and Vincent, 1996).

A further conceptual framework in use is that of *control,* and domains of interaction where different forms of control are contested (Bolding *et al.*, 1995; Mollinga, 1995, 1998). These concepts have enabled researchers to study public intervention in irrigation in innovative ways (Mollinga, 1998), and explore dilemmas, misfits, and disagreements present in water delivery and irrigated agriculture (Diemer and Huibers, 1996). A complementary concept now developing with my Chair is that of sociotechnical regimes in local agro-ecology. This looks more generally at the mechanisms developed by irrigation users in their struggle to achieve desired water distribution and production, given their knowledge and control over ecological and societal dynamics. It brings a greater focus on agro-ecology to complement ongoing work on irrigation system technology. It also enables study of opportunities and dilemmas arising

when operational conditions change, as when water scarcity emerges, or support services are suddenly removed.

The group now places its sociotechnical approach into a broader framework of agro-ecological development studies. Such a framework gives freedom to look at societal objectives in development, whether for economic transformation, or other interests in ecological and economic sustainability. This also helps the new international profile of the group, enabling us to work with water management in Europe as well as the Tropics within the same conceptual approach.

Finally, we hope this framework of agro-ecological development studies may provide a means of better collaboration at Wageningen, as different groups come to recognise the strengths of each others approaches, rather than their weaknesses.

Achievements of the sociotechnical approach

It is against these different resource approaches to irrigation, that we can understand the boundaries of research on water and irrigation at Wageningen, and collaboration across them. It is against these different technology approaches that the irrigation group participates in its professional debates. We are well aware of critics who would like us to take other approaches. However, the sociotechnical approach has brought much new understanding in irrigation. I would like to summarise some of the achievements of the irrigation group under Professor Horst, which also gave a real impetus to my own start here. Important themes of work include:

Better understanding of the inter-relations of infrastructure and management needs, and technology and property relations. This has involved the group in an active critique of hydraulic control structures and irrigation schedules, and their potential to deliver required water supply (Hoogendam, 1993; Horst, 1990, 1983; Jurriens and Mollinga, 1996; Mollinga, 1998; Pradhan, 1996). The group has also worked with indigenous technologies to study how they integrate hydraulic and institutional dimensions (Parajuli, 1997). The group has also researched the impacts of state disengagement in irrigation management, and the operational problems facing farmers under new management regimes (Oorthuizen and Kloezen, 1995). This debate has helped to stimulate a re-evaluation of control structures, water delivery methods and management practices.

Analysis of design processes and design paradigms in irrigation, to understand the causes of poor system operations and performance. This has also led to better understanding of farmers practices, and why and how farmers often adapt irrigation structures. (Bolding *et al.*, 1995; Diemer and Huibers, 1996; Hoogendam, 1993; Horst 1993; Manzungu and Van der Zaag, 1996; Ubels and Horst, 1993). In some cases this has led to immediate local discussion and new attention to local design criteria and construction arrangements (Van Halsema and Murray-Rust, 1997).

Studies on communication between engineers and irrigators. These have led to better understanding about problems in design, operations and renovations, and facilitated participatory technology development (Diemer and Slabbers, 1992; Scheer, 1996). This has

had direct impacts on work processes of NGO's in the field of irrigation (Boelens and Doorenbos, 1996).

Research on the adoption and impact of irrigation technology. Studies have shown beyond doubt that technology is not neutral. Wageningen researchers have studied the use of irrigation in rural development programmes, and the relationships between irrigation development and small farmers (Mollinga, 1998; Van Bentum, 1995). Irrigation and gender relations have been a subject of special interest. Again, sometimes this research has led to a direct change in technical assistance (Van Koppen and Mahmud, 1996).

Irrigation and the new policy agenda: Management for Scarcity, Sustainability and Security

These above-mentioned sociotechnical themes will continue, but also be reshaped by the new policy agenda of irrigation. I now want to highlight some new directions of work emerging under my tenure: into irrigation that is adapted to **scarcity** of inputs, **sustainability** of a system and its environment and **security** of livelihoods and food supply. I believe that the sociotechnical approach will expand understanding of all these areas.

Scarcity of water is emerging as one of the major preoccupations for the twenty-first century. Irrigation is seen as one sector where major savings must be made to provide water for ever-expanding cities and industry. Our research will involve more study of conflict and negotiation over proposed changes in

water supply. We know that the technologies in place will play an important control on points of action. Thus we have developed a framework to study prospects for water scarcity resolution in different contexts (Vincent, 1998). Increasingly, farmers are expected to pay the full cost of their water supply. Yet in many systems, it is still almost impossible to measure water, and farmers still work with shares rather than volumes. We are now studying the prospects for volumetric control in irrigation systems, and looking at options for change in water delivery systems (Vos, 1996).

We also know from the field, that it is not water scarcity alone that will shape technology development. New contexts of labour scarcity, and shortage of investment capital, also shape the options for modernization to resolve water scarcity problems. We hope to look at these different complexes of scarcity and how technology options emerge for them. Finally pressure on water resources has put the spotlight on specific design criteria. The concept of irrigation efficiency has often been criticised (Vincent, 1989; Van Vuren, 1992), but is now under widespread attack. We hope to participate in this international debate, to help find design concepts that are meaningful for both irrigation technology operations and water resources management (Prieto, 1996).

The concept of **sustainability** can be applied in several ways - towards environmental stability, viable administration, and durable and functional infrastructure. Research in our group is already active in these areas. Research has studied farmers'

knowledge and water management practices (Van Halsema, 1997; Jacobs *et al.*, 1997; Kielen, 1996; Ringersma, 1997; Wahaj, 1995). This not only helps understanding of the interactions between irrigation and the environment, and of farmer practices. It also help to establish what new innovations are adoptable by farmers. Our concern for sustainability also leads us to look more generally at the interaction of irrigation and water resources, to study possibilities for improved water management (Bolding, 1996; Boelee *et al.*, 1997).

We continue to work with groups affected by state disengagement from irrigation management. We hope this research will help understanding of how institutions evolve, and create sustainable systems. This brings us into research on intervention processes. We now have a special interest emerging in 'process projects' committed to greater user involvement and participatory technology development.

We are participating in the debate on sustainable infrastructure development in several ways. We are studying concepts of modernization applied in irrigation technology, to see how they are shaped by societal and environmental considerations (Prieto, 1995; Van Halsema, 1996). However, we are also looking at the survival and evolution of indigenous irrigation technologies (Shah, 1996).

The **security** of food supplies and livelihood strategies under irrigation now receives almost as much attention as water scarcity. Irrigation currently provides about 40% of world food supplies. However, it is also

predicted that up to 80% of future increases in food supplies must also come from irrigated agriculture. But there is little new land and even less water for expansion. Increases must come from improved yields, hopefully with better environmental management and lower water use at the same time. We know, however, that for farmers to participate in these wider goals, their own livelihoods must be secure and profitable. We are already developing some new research around irrigation and poverty alleviation. We know that irrigation is valued by the poor, and we are concerned they maintain their access to water supply to improve their livelihoods (Van Koppen, 1997). We will be looking at the prospects for farmers to manage water better in production. However, we will place this analysis in the context of on-farm resources and agrarian relations, and not just norms of water application.

We also hope to contribute to the general debate about low external input agriculture. It is indeed an important model for sustainable development. However, we remain uncertain how feasible it is in the short-term for irrigation, with its high external inputs of water, labour, nutrients, energy and capital. We think it unlikely that irrigated agriculture can shift rapidly to totally organic forms while also providing high output levels. We plan instead to begin research on irrigation which has Balanced External Inputs, and Positive Livelihood Impact. We support irrigation in which inputs can be more systematically related to outputs, negative externalities are reduced, and where users face lower risks and higher returns in their livelihood strategies.

In conclusion

Scarcity, sustainability and security are of course inter-related. In the Irrigation and Water Engineering group we often refer to a particular drawing by Escher - The Waterfall. It has so many elements that symbolise current concerns. In the background you can see the stable terraces with their neat water channels. You can see beautifully constructed canals of some architectural majesty. The water flows in a circuit with no losses. It also flows without controls, or people to operate them. You can see a well-managed plot, secure households, and even a bystander gazing on the aesthetic beauty of it all. This seems the ultimate dream for irrigation.

The only problem, of course, is that the canal system at the centre of the vision is an illusion. This magnificent water system can only exist in the mind of the artist and the observer. Not only can water not flow uphill: canals and agriculture cannot operate without controls and without people. So, the picture becomes a metaphor for us: to change ideas about irrigation management: to get users into the picture, and to restore realism into understanding of system operations.

We know that water does not flow uphill, but we do believe that science can recombine with experience, invention and dialogue to create water systems that work in harmonious ways. What has to change? Well, we have many engineers and philosophers of science who point the way.

As one eminent structural engineer (Billington, 1983. p.xii) has written:

...'All engineers in the late twentieth century need to know the computer well: all designers need to keep from relying on it for their basic structural experience'.

There are many agronomists who feel the same way. We hope we can reconcile technical realities with scientific norms and social aspirations, through sound local field work, talking to farmers, and learning the science and art of good design. These are the skills we are promoting in our study programme of Tropical Landuse.

We also want to maintain an open mind, without biases in technological choice or over-confidence in our knowledge. I close my speech with some old words from T.H. Huxley, a writer who managed to criticise both Religion and Science in the debate on evolution. Huxley thought that:

'Irrationally held truths may be more harmful than reasoned errors'...and...

'logical consequences are the scarecrows of fools and the beacons of wise men'

Huxley, 1877.

His comments are as appropriate for the world of the Sumerians, as for contemporary water management.

Mijnheer de Rector Magnificus, ladies and gentlemen

I thank you for this chance to discuss the logical consequences of societal intervention in water management, and the new agenda of scarcity, sustainability and security. We have some beacons to help understanding, and we will try to train students who can reason the errors. We have an approach which we plan to apply to substantive issues for irrigation and international development. In the words of the Sumerians, we think these ideas will help ..'to keep the dykes and canals under direction'... and create sustainable irrigation practices for the twenty-first century. I hope I have shown you that Wageningen continues to be a relevant and committed partner in this endeavour.

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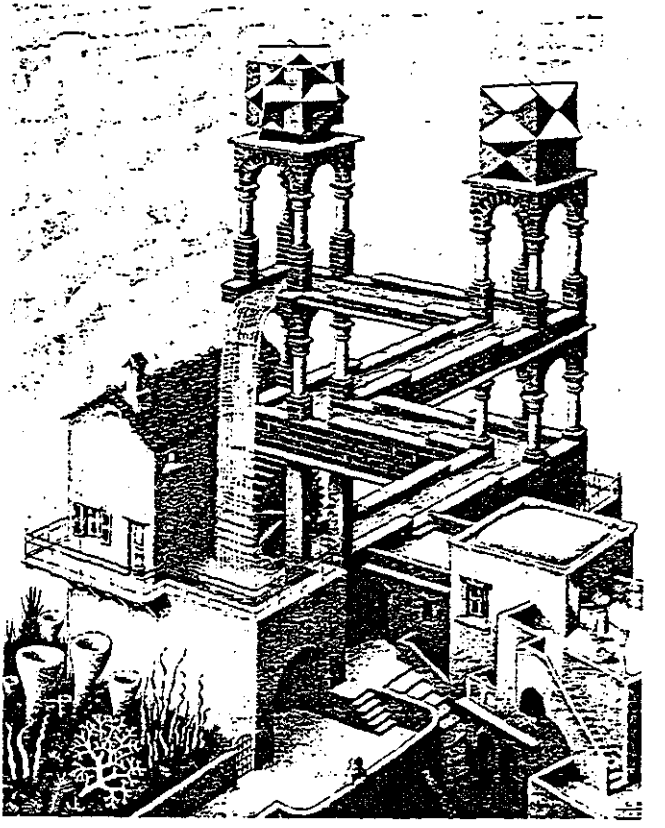

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