Integrating Water Management and Spatial Planning through Serious Gaming: The Water Game in the Netherlands

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Abstract **– Policy issues in water management are *multi-level, multi-scope, multi-disciplinary* and *multi-actor* problems. In such a context the regime of water management is highly *fragmented*, e.g. among many different (governance, spatial) levels, (knowledge) disciplines, institutions and networks. Policy paradigms therefore call for (more) 'integrated approaches' as in the case of *Integrated Water Management* (IWM). The question however is what Integrated Water Management (IWM) actually entails, and how it can be realized and supported in practice. In order to better understand and manage IWM in a context of spatial planning in the Netherlands, a 'serious gaming suite' called the Water Game was developed. This serious gaming suite renders itself to develop realistic, computer-supported, multi-player policy games. It is assumed that by gaming the socio-technical complexity of integrated water management – partly in a virtual game environment - stakeholders gain a better understanding of the interrelations between the various policy subsystems and policy actors; which should enhance integrated planning in real life. Up to now, various pilot games in the Water Game suite have been developed and played. But the effectiveness of the Water Game suite, the underlying theory and its potential effects for real life, still need to be validated. In this paper, the authors describe the underlying theory of IWM, present the Water Game suite as a potential support tool. The main findings of a first validation study are that the current prototype of the serious game platform performs well on several criteria and that players significantly support the fact that the gaming experience increases their understanding of integrated planning.**

I. Introduction

Policy issues in water management are *multi-level, multi-scope, multi-disciplinary* and *multi-actor* problems. As a result, water management[1] is highly *fragmented*, e.g. among many different (governance, spatial) levels, (knowledge) disciplines, policy actors and networks. Recent policy paradigms therefore call for (more) 'integrated approaches' as in the case of *Integrated Water Management* (IWM). The underlying question is, what IWM actually entails – what is integrated with what? - and how integration can be realized in practice. In this paper we examine whether and how *serious gaming* can be used as an integrated method for IWM.

The outline of the paper is as follows. First, we will discuss the characteristics of policy problems in water management in order to understand the underlying causes and dimensions of 'fragmentation'. Then we will introduce and define IWM. We examine some general requirements for integrated methods that are able to address both the technical-physical aspects of and the socio-political aspects of water management. In the second part of this paper, we explore the use of *serious gaming* as an integrated method for policy-analysis in a context of water management and spatial planning. This is embodied in the presentation of the Water Game: a suite for developing realistic, computer-supported, multiplayer, policy games. Various pilot versions of serious water games have been played with professionals from water management and planning institutions in the Netherlands. We will describe the general background, and game-play and present the first results from a validation study.

II. Fragmentation

If water management needs to become (more) *integrated*, the most likely reason is that it is now *too fragmented*. The main reason why water management is fragmented is that policy problems in water management (WM) – s.a. *flood control*, *river basin management*, *natural resource management* - have distinct characteristics that make them *messy or wicked*.

First of all, policy problems in WM are subject to a great many vigorous ecological, economic, cultural, societal and political *trends*, s.a. population growth, urbanization, economic development, migration, land-use, climate change and geopolitics. Many of these trends are interconnected. Their long term effects on water, ecology, economy, etc. are not well understood and highly uncertain, well into the future.

Second, most issues in water management are *multi-level* which implies that problems and solutions at different *spatial scales* and/or *administrative and governance levels* – i.e. local, regional, (inter)national, global - are strongly interconnected. The causes of climate change for instance are global but the consequences and adaptive policy responses are often local and regional.

Third, water management issues are highly *interconnected*, not only among themselves and at different levels, but also in relation to issues and policies in other planning domains such as housing, industry, transportation, utilities, agriculture, etc.

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[1] The definition of water management can be really broad and confusing. To be precise, the meaning of water management in this paper is to do with all types of decisions and policy planning etc. directed at water related issues such as water safety, quantity and quality control.

Fourth, water management policy problems can usually be framed from a number of different *perspectives*; either from a disciplinary perspective – i.e. an engineering, economic or cultural framing of the policy problem. Or they can be framed from different policy belief systems. Belief systems have their roots in 'deep core' values and divergent viewpoints on 'knowledge', e.g. about the sources or reliability of data or the underlying cause effect relations. Hence, different belief systems can give rise to conflicts between opposing policy communities that advocate different solutions, such as 'giving more space to the river' or 'controlling the river by heightening the levees'.

Fifth, issues in WM are highly *socio-technical* in nature. This implies that the technological-physical and societal-political dimensions of the policy problem are highly interwoven and are difficult to separate. 'Hard' scientific data, models, engineering and technology etc. are closely tied to all kinds of interrelated, interdependent and interacting stakeholders – scientists, engineers, environmentalists, citizen groups, policy makers and policy advocates, etc. - who form a (policy) network and operate in a policy arena.

Sixth, the domain of water management is 'driven' by a high level of *expertism* and *professionalism* - a *technocracy* build up for many decades, even centuries, in well-established, even dominant engineering institutions such as the *Army Corps of Engineers* in the US, or in renowned knowledge institutes and companies like Deltares [2] in the Netherlands. Much of the knowledge on the hydrological, geophysical and even the economic aspects of water management has been incorporated in sophisticated computer models and simulations. These are used to support engineering and planning, e.g. through processes of data-analysis (e.g. of water levels, flows), forecasting (e.g. prediction, scenario generation), evaluation of options (e.g. cost benefit, impact or risk analysis), etc. The dependence on the institutional technocracy, hard data and computer models has its downsides. One of them for instance, the fact that many of the computer models and simulations often remain a black box to policy makers or other stakeholders. On the other hand, water management involves many subjective, social-cultural and political aspects that cannot be quantified or put into simulation models. Therefore, other ways than computer models are needed to understand and incorporate knowledge into the planning process, most often through some interactive stakeholder-learning process.

The last characteristic of water management in countries like the Netherlands, concerns the high level of *institutionalization*. On the one hand, water management has largely been institutionalized in all kinds of legal and formal planning procedures which define the steps of political decision-making as well as the authorities, responsibilities, rights and duties of the various stakeholders. On the other hand, and due to the characteristics described above, decision-making in water management takes place in a political reality characterized by stalemates and deadlocks, strategic behavior, fits and starts, conflicts and fights, uncertainties and mistakes. In other words, planning very seldom is a neat linear and rational process but takes place in messy rounds and iterations, where stakeholders enter and leave the arena at will.

As a result of the above, water management tends to be highly *fragmented* in different levels of governance (see Table 1), policy domains and knowledge disciplines. New policy paradigms therefore call for (more) 'integrated planning approaches' and Integrated Water Management (IWM). The question however is what Integrated Water Management (IWM) actually entails, and how it can be realized and supported in practice.

TABLE 1: FRAGMENTATION IN POLICY MAKING

1)	Macro trends: e.g. climate change, migration, deforestation, agriculture
2)	Spatial scales and administrative /governance levels: local, regional, (inter)national, global
3)	Spatial planning domains, e.g. transportation, housing, ecology, agriculture, etc..
4)	Stakeholder perspectives and frames: e.g. values, interests, beliefs, power,
5)	Technological-physical and Social-political knowledge: hard, formal and quantitative data (models, etc.) and soft, interpretative qualitative information
6)	Science disciplines, e.g. engineering, social-economic-political science, etc.
7)	Formal and informal planning processes and institutions, e.g. actors, time-scales, legislation, etc.

III. INTEGRATED WATER MANAGEMENT

A. Background

The notion of integration has been widely discussed in various branches of environmental management. It suggests a more interactive and interconnected approach in environmental decision-making while taking into account all the affected entities both from a natural and a societal aspect [1, 2]. In water management there are a number of definitions of integration available in the literature [3]-[5]. One of the most recent definition is Integrated Water Resource management (IWRM) which describes it as being "a process to promote the coordinated development and management of water, land, and related resource, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystem" and "it should be based on a participatory approach, involve users, planners and policy makers at all levels" [6]. In practice the concept of integrated water management has been adopted in different countries and areas. See e.g. [7]. In the Netherlands the concept of integrated water management was

[2] Deltares is a leading, independent, Dutch-based research institute and specialist consultancy for matters relating to water, soil and the subsurface.

adopted by the Dutch government in 1985. The integration in the water policy was proposed to achieve 1. The internal coherence of water safety, water quantity and water quality; and 2. The external coherence e.g. attune the policy of water management to environment, agriculture and physical planning [5]. To give an overview of how integration can entails fragmentation table2 generalizes the main aspects of integrated water management.

TABLE 2: MAIN ASPECTS OF INTEGRATED WATER MANAGEMENT

1)	Management style: Mutual learning, self-organization, interactive and participatory
2)	Structure of governance: Polycentric, horizontal structure
3)	Analysis style: Cross sectorial analysis; address trans boundary problem..
4)	Information source: Open and shared information source, facilitating the comprehensive understanding
5)	Finances structure: Diversified financial resources involve the broad set of private and public financial instruments
6)	Environmental criteria: Both quantifiable and qualitative indicators from different perspective
7)	Methodology: Social interactive methods; combining formal analytical tool and participatory process
8)	Attitude towards uncertainty: Adapting the system to uncertainty through social learning.

In the concept of integrated water management participatory approach has been recognized as the principle. The management style should be based on interactive participation. In 2000, the European Water Framework Directive (WFD) adopted an integrated approach to water management and recognized the importance of social participation through which IWM became connected to methodologies of societal participation and stakeholder interaction [8]-[9]. In the Netherlands the process of developing integration the water management regime has been observed more interactive due to the involvement of stakeholders [10]. In our view, the requirement of participatory integration implies that a socio-technical systems perspective in planning is necessary. In short, the technical (hydrological, ecological etc.) aspects of water management need to become interconnected with the social-political aspects. This implies that different forms of knowledge and power need to interact in order to develop a shared view on the complex behavior of the socio-technical planning system at hand.

B. Methodological challenge

As the world bank report stated that "the main management challenge is not a vision of integrated water resource management but a 'pragmatic but principled' approach" [11]. As Table 2 shows, the requirement of integrating various dimensions of *fragmentation* are plenty – and so are the various modes and forms of *integration*. For those who prefer a formalistic perspective, IWM could mean the incorporation of water management issues into formal spatial decision-making procedures, at various levels of governance. For others, who opt for an engineering approach it might mean the integration of different forms of (scientific) knowledge, like ecology, civil engineering, hydrology, urban planning, etc. Others have argued that IWM should be viewed as an ongoing social learning process where many stakeholders – experts and non-experts, policy makers and citizens – are involved.

The different views on policy analysis – reduced here to a simple dichotomy of a rational-linear mode of policy analysis and a political-interactive process of policy analysis – both have advantages and disadvantages. This is especially true in a socio-technical domain like water management, where hard facts, evidence, science and models have as much credibility, usefulness and relevance, as qualitative knowledge and insights of stakeholders. In other words, the inherent dilemma in socio-technical policy domains such as water management is that rational-scientific analysis and the social-political process are intrinsically connected – as two sides of the same coin. They are sometimes considered irreconcilable because there are big differences between the scope, method and even conflicting epistemologies, but also increasingly regarded as mutual reinforce approaches to deal with the social technical problems.

The process of policy analysis is a constant balancing between delivering usable knowledge to policy making and avoiding 'superfluous knowledge' – i.e. scientific knowledge that is not used politically - and 'negotiated knowledge' – i.e. political compromises that are not based upon facts or knowledge [12]. This implies that the policy analysis for integration, is in need of a next generation of methods and tools that are able to analyze the technical-physical complexity and the socio-political complexity of policy problems in an interactive fashion. In recent year considerable efforts made to enrich the interactive tool box such as participatory modeling, interactive model use and gaming. In the remaining part of this paper we argue that this next generation of methods that are able to cope with socio-technical analysis of policy problems is derived from simulation - gaming. It is assumed that by gaming the socio-technical complexity of integrated water management – partly in a virtual game environment - stakeholders gain a better understanding of the interrelations between the various policy subsystems and policy actors; which should enhance integrated planning in real life.

IV. SIMULATION- GAMING

The development and application of advanced models and simulations for spatial planning and water management has a long and established tradition. But the use of models for planning and policy making has also been problematized since the late 60s, early 70s, for an overview, see [13]. Various authors and streams of thought have pinpointed at the non-effectiveness, even irrelevance and manipulation of models and simulations for planning and policy making [13].

With regard to planning, considerable efforts are now being made to develop and use so-called *integrated models*, i.e. simulation-models that are able to communicate or integrate realistic data and insights from different relevant knowledge domains, such as transportation, noise, water, land use models etc. The assumption is that integrated modeling enhances integrated planning. And due to the emergence of integrated planning paradigms, like IWM, there is also more demand for integrated models.

In many instances, such integrated models are also being used to facilitate an interactive learning process among policy stakeholders. In some cases, a kind of role-play or policy game is designed around the (integrated) model(s) to facilitate the interactive learning process among the actors.

Hence, when simulation-models become intrinsically connected to stakeholder interaction we enter the field of simulation-gaming or serious gaming. When one or more human actors become part of the simulation, it is not uncommon to call it a social simulation or an interactive simulation. But when there is also a set of rules for human interaction involved, and actors have certain goals within the simulation, it becomes a simulation-game or a serious game.

(Serious) gaming-simulation can be defined as: experi(m)ent(i)al, rule-based, interactive environments where players learn by taking actions and by experiencing their effects through feedback mechanisms that are deliberately built into and around the game. Gaming is based upon the assumption that the individual and social learning that emerges in the game can be transferred to the world outside the game. This transfer is largely negotiated and not immediate, thereby making a simulation game low in external risks and giving the players a sense of safety, which is a prerequisite for experimentation and creativity." [13]

Examples of integrated models that have been used as a model-core for policy games are SimLandscape, -Airscape en -Waterscape (Alterra, RGI e.a.) en Urban Strategy (TNO). Although, these integrated models tend to be associated with (serious) gaming-simulation, in terms of game-play they are fairly limited. In terms of human-computer interaction and 3D visualization they have many similarities with serious gaming. But the simulation-models have not been designed as a games, they are merely being used for collaborative stakeholder experimentation with the model.

Entertainment computer games however increasingly serve as a source of inspiration and provider for developing serious games. 3D-Virtual representations have been turned into play-grounds for planning, community involvement and serious gaming. Serious gaming are now being used in different ways in the field of water management, e.g. to raise public awareness on flood control (FloodSim) or for emergence response training (Levee Patroller). In these cases, the model itself has been designed as a game.

It is expected that the use of game technology and concepts will revolutionize the possibilities of stakeholder interaction, collaboration and visioning. As researchers, we have used advanced forms of gaming, among others for port planning, spatial planning, water management, sustainable urban renewal, electricity networks and rail network planning. Based on the empirical experiments of gaming simulation and other interactive approaches, the characteristics of the methods and approaches can be generalized as below [14]-[16].

1) Integrative: they should consider different aspects and levels of design and decision-making in a holistic and systematic way.
2) Dynamic: they should be able to show the `performance' of various alternatives in relation to preferences and `behavior' of stakeholders.
3) Interactive: they should be able to support the negotiation process among stakeholders.
4) Immersive: players can become part of the simulation and present the realistic behavior as in the real problem.
5) Transparent: they should produce results that are clear and understandable to all stakeholders (that is, they should not be a `black box').
6) Flexible and reusable: they should be usable for, or adaptable to, a range of (similar) situations.
7) Fast and easy to use: the time required to apply them should be relatively short, and non-experts, for example, residents and politicians, should be able to use them.
8) Communicative and educational: they should be able to convey meaning and insight to stakeholders about problem structure, alternatives, and different perspectives.
9) Authoritative: they should meet analytical standards (of, for example, validity) and political standards (for example, safeguarding core values and timeliness) in order to increase the likelihood that the outcomes are used.

V. Research questions

We discussed above the theoretical importance and the dilemma of combining scientific rationale and social political process through modeling and participation. And the research interest on gaming simulation as one of the promise to contribute. Based on this analysis we will formulate the case study to investigate the Water Game in the Netherland in order to answer two research questions:

1) What is the validity of serious gaming to support policy analysis on the interaction of water and other spatial functions?
2) How can serious gaming be used to combine modeling and participation for the purpose of knowledge

integration in water management and spatial planning?

The two research questions are methodological questions to examine the usefulness of gaming simulation to help social technical policy analysis. The first question concerns the modeling and simulation of the interactive dependence between water and other social functions in the spatial planning and developing process. The second question is to judge the effectiveness of gaming simulation as the special application to combine rational analysis and interactive process.

VI. THE WATER GAME

A. Background of the game

The Water Game suite is owned and developed by the company RO[2] – a joint venture of Tygron Serious Gaming and the consulting firm, Ambient - with the support of a Dutch government funded knowledge program "Leven met Water" (transl. Living with Water)[3] and a related regional governance program "Waterkader Haaglanden". The various serious game cases in the Water Game suite have been developed with the support of a great many companies and institutions that have expertise and experience in the field of water management such as Deltares, Strategis, UNESCO-IHE and Synergy. Original ideas for this type of serious, multi-player, computer supported planning games go back to earlier versions of serious planning games developed at TU-Delft a.o. Sim Maasvlakte 2 about a major port expansion project in the Port of Rotterdam [17] .

B. The Water Game suite

The Water Game is a *suite* [18]. for building and playing serious games - although many of the serious games that have been developed and played within the suite are sometimes also referred to as the Water Game. A suite is a kind of platform or environment for developing, playing and debriefing various customized serious games that belong to the same *game family*. A suite is a well-defined, integrated, modular set of software components (the game-engine), a network-architecture, services (e..g for scenario-building, logging, etc.,) and formal and informal procedures for developing a game (e.g. to create a policy context, to define player roles).

The advantage of using a gaming suite is that it allows tailoring and customizing a serious game to a specific client-problem-learning context, while development time and costs can be reduced by reusing software, content, game formats and supporting tools. Another advantage is that user and player experiences continuously lead to an improvement of the suite itself. Van Houten [18] for instance developed and studied a suite for *distributed, real time supply chain games* where scenario's (players/agents, products, locations, learning objectives, time, screens and interfaces, etc.) could be customized and where learning processes where supported by services like performance logging.

[3] The program Leven met Water (living with Water) is a four year (2004-2010) 50 million euro, government co-funded research and knowledge program in the Netherlands, initiated by a large number of public and private partners and financed by so-called ICES –KIS funds.

The Water Game suite has specifically been developed to address serious games of the following game family:

1) Multiplayer: usually 4 roles about 4-6 players in one game-instance.
2) Computer-supported: 2D and 3D-graphics, simulation, advanced player-computer interaction, etc.
3) Socially interactive: players interact socially in the same physical space
4) Multi actor, strategy games: long term decision-making (5-30 years), strategic behavior of the players
5) Interactive, integrated water management: stakeholder involvement, multiple policy domains, levels, etc.
6) Urban or spatial planning: player interactions revolve around spatial planning in a shared virtual space (SimCity style)

In the modeling tool, a database is related to a set of user interfaces which provides 3D maps of the current and future situation, the actions and decisions of the players, and a multitude of performance indicators of the individual player, a subset of players or the system as a whole. The Water Game is characterized by high quality 3D-visualization, user interaction and continuous feedback.

C. Audience

The serious games developed in the Water Game suite are multi-purposed. They are and can be used as part of general learning or training events such as workshops, seminars, training courses, etc., or formal education such as at schools. The main audience for the Water Game platform and games however are professionals that work as policy makers, stakeholders or knowledge brokers in one of the relevant domains of water management and spatial planning.

D. Cases

Serious Games in Water Game suite have a common objective and structure of game play. The detailed role descriptions, goals and activities in the game and the performance indicators are adapted to the specific problem-client context. The general objective of a serious game in the Water Game suite is to gain better insights in the domain of water management and spatial planning, to create policy support and to become conscious about future developments and the influence on spatial planning in the region. Dependent of the background of the participants and their involvement in the real world problem, the specific objectives of a serious game or session can differ. Up to now, the Water Game suite has been used as a platform to develop serious games for three cases:

1) The Integrated Water Management Game. A serious game about and for the real development of a new urban area and water management issues in the municipality of Tiel in the Netherlands.

2) The Climate Game. A serious game about a real project for adaptive policy making to climate change. So far this game on water management and urban planning has been developed and played for the municipality of Delft, in the Netherlands.
3) A serious game on decreasing population (in Dutch: Bevolkingskrimp). A serious game about a fictitious city in an area in the Netherlands that is faced with a decreasing population. This game, so far has been played in several regions in the Netherlands, with stakeholders. It has now also been adopted as general training and learning tool.

E. Game play

A typical session of a serious game developed and played in the Water Game suite, goes as follows. Depending upon the total number of participants, the group is split up into a number of parallel subgroups that consist of 4 to 6 persons. Each subgroup forms a team that plays one game instance of the same serious game. With two or more subgroups, the process, experiences add results can be compared, which is trigger for learning. Within a team the players are divided over four roles. In general, these roles are 1) the *municipality*, 2) the *water boards*, 3) the *housing corporation* and 4) a *property developer*. Player roles can easily be adapted to suit specific problem/client/learning contexts.

The players together have to (re-) develop a spatial area – say a part of a real or fictitious municipality - to deal with changes in the environment, e.g. a new urban area to be developed, a decreasing population, climate change, etc. - and reckon with some financial constraints, e.g. budget constraints or an economic down turn.

Within a game, there is a set of objectives and interests for each player as well as for the team. Like in reality, this set is a mixture of individual and collective, formal and informal, clear and ambiguous, explicit and implicit goals and interests. Each player-role has some individual objectives and interest. The property developer for instance is driven by profit, while the water board aims to keep the area safe against flooding.

After a short introduction of the objectives and game play, the first round of the game commences. During the first round the players can make various changes in the spatial environment. This spatial environment is usually a realistic simulation of the area under study with actual 3D maps and data. Players can take a multitude of planning actions in the game, like building or adapting houses, (new) water works, infrastructure, etc. thereby trying to reach their individual and collective objectives and values such as sustainability, profit or safety. Players can take their desired actions individually, but after some time will discover that without coordination and integration, their collective objectives will most likely not be reached. They will start to realize that this might also affect their long term individual performance. Hence, communication and negotiation between the stakeholders is necessary. Stakeholders will need to plan integrally.

After some time, the game will be paused for reflection and intermediate debriefing. The various performance indicators, s.a. livability, sustainability, water storage facilities, finance etc., will be shown on the players and central screen so the various player and team scores can be compared. The players will reflect on the progress so far and the intensity of working together. After some time the second round starts with the same process as the first round. This continues until the area is (re-)developed and/or playing time is over. At the end of the session, all participants discuss their experiences together in the debriefing. This debriefing is facilitated by the game leaders and they try to give a shared view of the learning experiences of all participants and point some actions for the future.

Pictures 1a-d: Various impressions of the Water Game

VII. Evaluation approach

A. Method

For the learning experience of the players, for research purposes and for the transferability of insights, it is important that the progress of the game, the experiences within the game, the decisions and their effects, the discussions and insights are recorded. In the Water Game, we make use of the following complementary research and evaluation methods:

1) Initial questionnaire: backgrounds of the participants (age, gender, experience with gaming, etc.), their involvement with and influence on the subject, the impression that the participants have of the real policy processes, etc.
2) Questionnaire during the game: concerning the game play and the progress of the policy process in the game.
3) Observations during the game: concerning the way in which the game is played, how the players organize themselves, what content-based and policy measures are taken, how the players interact with one another, what problems they identify and what strategies they follow, etc.
4) Group discussions at the end of the game: on the experiences in the game, the lessons for the situation in reality and the relevant knowledge-based questions, on the improvement and continued development of the game, etc.
5) Logging of data in the computer/calculation model: on the choices and decisions of the players, the various maps showing the development of the station areas, the results and effects of the players' decisions on a large number of indicators such as the increase/decrease in the number of passengers, etc.
6) Questionnaire after the game: on the impression that the players have of the quality of the game, the manner in which they have played the game, the use of the computers, the insights and relevance to policy, etc.
7) Data gathering and response

A large number of Water Game sessions have been held since the development of the first prototype in 2008. Many gaming sessions were held for demonstration and general learning purposes. Around five sessions with a total of about 100 stakeholders have been held as part of the three above-mentioned policy making cases. After playing one of the game-sessions – the decreasing population game, see above - a total of 17 players filled in a questionnaire, made up of questions on the quality of the game and their learning experiences.

In the remaining of this paper we give an impression of the preliminary results of the Water Game on the basis of questionnaires and observations. In order to benchmark the Water Game, we compare the results to two similar policy games that have been played with professionals: SimPort MV2 [17] and SprintCity [18] - [20].

B. Limitations

The effectiveness of the Water Game suite, the underlying theory and its potential effects for real life, still need to be validated and is part of academic PhD research. The extent, depth and reliability of the results and insights are as yet limited. The number of sessions and respondents is small, particularly for extensive measurements. The accompanying evaluation and research instruments are in intensive development in parallel to the development of the game. At the end of this paper we describe the way in which Water Game can generate more and better research data and policy insights.

VIII. Preliminary results

A. Validation of the game and game play

Who are the player-stakeholders? As figure 1 and table 1 show, the participants in the Water Game session are professionals, the majority of them are, with limited computer game experience. A considerable number of them have taken part in game simulations or serious games before. Figure and table 1 shows that the average experience in terms of content, involvement in the real planning process and influence is fairly high (above 5 on a 1-7 scale) esp. as compared to the benchmark SprintCity game.

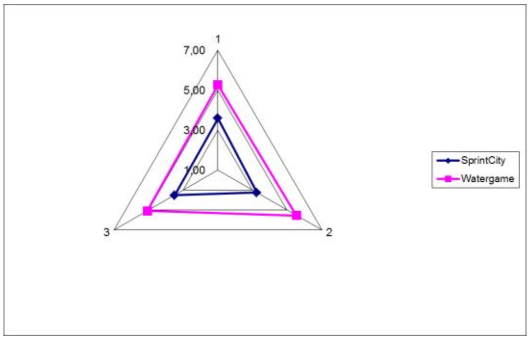

Figure 1: Involvement and expertise of the participants (1= Min; 7 = Max)

TABLE 1 EXPERTISE AND INVOLVEMENT OF HE PARTICIPANTS (WATER GAME)

Question (scale 1-7; n = 17)	Mean (std)
1. Not at all / very much a subject matter expert	5,27 (1.9)
2. Not at all / very much involved in the real planning process	5,54 (1,6)
3. Not at all influential / very influential in the real decision-making process	5,08 (5,1)

How do the players experience the quality of the game? Figures and tables 2-3 give an overview of the perceived quality of the Water Game. The results shows that the game is evaluated as rather positive, with average scores around or above 4 on a five-point scale. The general game play (figure and table 2) scores considerable better than the benchmark games SimPort MV2 (n = 70) and SprintCity (n = 45). The computer can generally be operated relatively easily, without too many malfunctions. But as compared to the two benchmark games, the use of the computer in the Water Game has about the same or a little lower performance (see figure 3 and table 3).

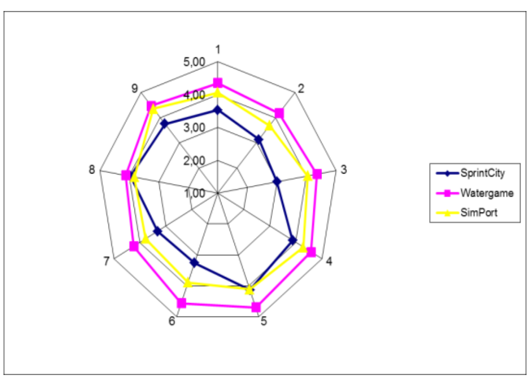

Figure 2 Benchmark of the Game design quality

TABLE 2: GAME DESIGN QUALITY

Question (mean, scale 1 = str. disagree-5 = str. agree)	Water Game (n = 17)
1. The objective of the simulation game was clear	4,35 (.79)
2. The instructions and explanations at the start of the simulation game were clear	4,18 (.81)
3. The aim of the simulation game was relevant for policy support	4,35 (.61)
4. The simulation game was built up in an interesting and motivating way	4,59 (.71)
5. The simulation game was well-led by the instructor(s)	4,71 (.47)
6. Given the aims of the simulation game, the simulation was sufficiently detailed	4,56 (.51)
7. Given the aims of the simulation game, the simulation was sufficiently realistic	4,24 (.75)
8. Good feedback was provided during and immediately after the game	4,13 (.72)
9. I found it educative to take part in this game	4,47 (.62)

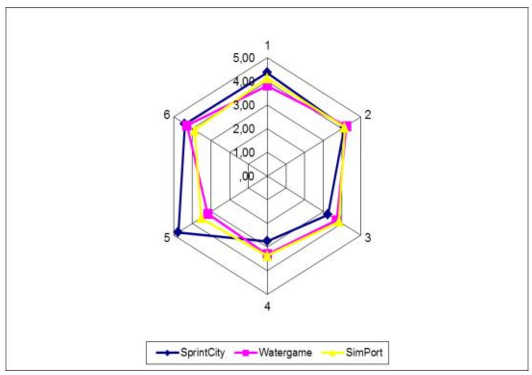

Figure 3 - Benchmark of the computer use

TABLE 3: COMPUTER USE

Question (mean, scale 1 = str. disagree-5 = str. agree)	Water Game (n = 17)
1. The computers in the game were easy to operate.	3,82 (1.2)
2. I enjoyed using the computers in the game.	4,24 (.9)
3. The user screens (interfaces) in the game gave enough of a sense of the changes in the process	3,71 (1.1)
4. I had a clear feeling of time IN the game.	3,29 (1.0)
5. During the game there were few or no computer malfunctions.	3,18 (1.4)
6. When there were computer malfunctions, these were quickly and satisfactorily remedied.	4,29 (.59)

B. Policy-oriented learning

How do the players evaluate the policy process in the game? Figure 5 gives an overall profile on 8 scales (1-7) on which the participants evaluate the policy process in the game.

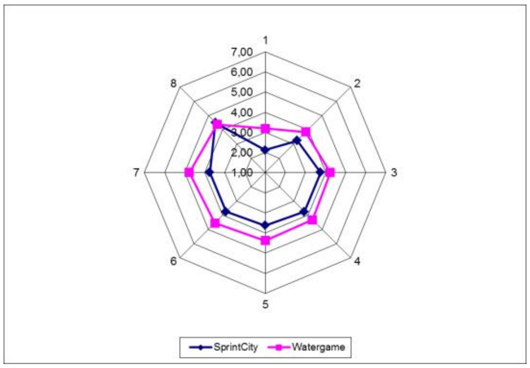

Figure 4 Benchmark of the game process

TABLE 4: GAME PROCESS

Question (mean, scale 1-7)	Water Game (n = 17)
1. Viscous – Decisive	3,15 (.1)
2. Conservative – Innovative	3.85 (1.1)
3. Out of control – well managed	4,23 (.73)
4. Every man for himself - good cooperation	4,31 (1.0)
5. Conflictious - Harmonious	4,38 (.8)
6. Disjointed – Integral consideration	4,51 (1.1)
7. Closed process vs Open process	4,77 (1.4)
8. Short term thinking vs long term thinking	4,38 (1.5)

C. What do the participants learn from the game?

Figure 5 and Table 5 give a profile of the policy insights that the players – in their own estimation – acquire in the game. On these scales (1-5) the players are moderately positive, but there is room for a strengthening of the effects of the game.

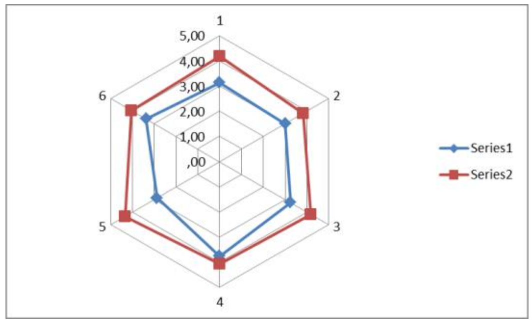

Figure 5 Benchmark of the policy relevance

TABLE 5: POLICY RELEVANCE

Question (mean, scale 1 = str. Disagree; 5 = str. agree)	Water Game (n = 17)
1. Better understanding in the interests and perspective of other stakeholders	4,18 (7.3)
2. Better insight in the different solutions and alternatives	3.82 (1.1)
3. The use of this serious game is valuable for policy and decision-making	4,18 (.73)
4. Gained more insight in long term developments	4,06 (1.0)
5. Gained more insights how decisions of various actors influence each other	4,35 (.7)
6. Gained more insights how decisions at different scales influence each other	4,06 (1.0)

IX. CONCLUSIONS

The knowledge that arises from playing the Water Game with stakeholders provides real-life input for further research and the continued development of the model and the game. In this way a fertile 'feedback loop' of knowledge is generated. Some important but preliminary conclusions (hypotheses) are:

By playing the game the stakeholders become familiar with the underlying (formal) model (in this case the complex relations of cause and effect).

By playing the game the stakeholders gain more insight into the interrelation between the technical-physical aspects (in this case the feedback in the model) and the politico-social aspects (the strategic behavior of the actors) on the various system and scale levels of the ~~Delta Metropolis~~Water Game.

By playing the game the stakeholders learn what their individual and collective roles and behaviors in that system are.

By experimenting in the game the stakeholders learn to develop and validate alternative strategies and potential management and action options.

Playing the game generates 'objective' information on the complex behavior of the system and the actors, established in the simulation model of the game.

Playing the game generates 'intersubjective' information on the complex behavior of the system and the role of the actors within it: the perceptions and opinions of the actors arising from discussions, observations and questionnaires, etc.

By giving feedback on the model and the game, the stakeholders contribute to the improvement and expansion of the model and the game.

By giving feedback on the model and the game, the researchers learn how Water Game, and gaming in general, can be better used for policy-relevant learning and policy research.

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