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10. Expert Judgement Assessment & SCENT Ontological Analysis

NICHERSU Iulian*, NICHERSU Iuliana, MARIN Eugenia, SELA Florentina, MIERLĂ Marian, TRIFANOV Cristian

Danube Delta National Institute for Research and Development: 165 Babadag street, Tulcea - 820112, Romania; e-mail: office@ddni.ro
**Address of author responsible for correspondence: Danube Delta National Institute for Research and Development: 165 Babadag street, Tulcea - 820112, Romania, e-mail: iulian.nichersu@ddni.ro*

Abstract: This study aims to provide insights in the starting point of the Horizon 2020 EC-funded project SCENT (Smart Toolbox for Engaging Citizens into a People-Centric Observation Web) Citizen Observatory (CO) in terms of existing infrastructure, existing monitoring systems and some discussion on the existing legal and administrative framework that relate to flood monitoring and management in the area of Danube Delta. The methodology used in this approach is based on expert judgement and ontological analysis, using the information collected from the identified end-users of the SCENT toolbox. In this type of analysis the stages of flood monitoring and management that the experts are involved in are detailed. This is done through an Expert Judgement Assessment analysis. The latter is complemented by a set of Key Performance Indicators that the stakeholders have assessed and/or proposed for the evaluation of the SCENT demonstrations, for the impact of the project and finally for SCENT toolbox performance and usefulness. The second part of the study presents an analysis that attempts to map the interactions between different organizations and components of the existing monitoring systems in the Danube Delta case study. Expert Judgement (EJ) allows to gain information from specialists in a specific field through a consultation process with one or more experts that have experience in similar and complementary topics. Expert judgment, expert estimates, or expert opinion are all terms that refer to the contents of the problem; estimates, outcomes, predictions, uncertainties, and their corresponding assumptions and conditions are all examples of expert judgment. Expert Judgement is affected by the process used to gather it. On the other hand, the ontological analysis comes to complete this study, by organizing and presenting the connections behind the flood management and land use systems in the three phases of the flood event.

Keywords: Horizon 2020, flood monitoring, expert judgment, SCENT Ontological Analysis, Danube Delta

INTRODUCTION

Scent is a European Union research project funded under the Horizon 2020 programme (https://scent-project.eu/). The project will engage citizens in environmental monitoring and enable them to become the ‘eyes’ of the policy makers. In doing so citizens will support the monitoring of land-cover/use changes using their smartphones and tablets.

The project will demonstrate the huge potential of citizen observation and monitoring of the environment. A people-led online observation movement will capture land-cover/-use changes through user-friendly tools and technologies, i.e. the Scent Toolbox. This will complement existing forms of monitoring such as satellite and remote sensing which are costly and less dynamic. The Scent toolbox will be tested in two large scale pilots; the urban case of the Kifisos river in Attica, Greece and the rural case of the Danube Delta in Romania. The impact of the toolbox in the assessment of flood hazards and flooding patterns will be evaluated.

This study is based on the SCENT Deliverable 1.1 ‘SCENT Stakeholder Analysis and End User Requirements’ where the analysis on contributions of stakeholders that participated to the project participatory methods was detailed, e.g. provided input to the questionnaires through email or semi-structured interviews, to the online surveys and/or participated to the focus groups organised in the two pilot sites. In this study, the analysis goes one step further, aiming to assess the profiles of SCENT expert stakeholders with respect to the Citizen Observatories for the two pilot sites, evaluating two factors:

- The specific phase or domain of involvement of stakeholders with respect to flood monitoring or managements;
- The level of direct impact that stakeholders have with respect to the pilot cases;

This assessment was performed using the Expert Judgement methodology. The study includes the application of the Expert Judgement and ontological analysis methodologies, aiming to provide a deeper insight into the scientific or operational areas of expertise of the SCENT stakeholders as well as to analyze the interactions between the relevant organizations in the different phases of a flood.

METHODS

1. Expert Judgement Methodology in SCENT

Expert Judgement (EJ) allows gathering information from specialists in a specific field through a consultation process with one or more experts that have experience in similar and complementary topics. Expert judgment, expert estimates, or expert opinion are all terms that refer to the contents of the problem; estimates, outcomes, predictions, uncertainties, and their corresponding assumptions and conditions are all examples of expert judgment. Expert Judgement is affected by the process used to gather it. EJ has uncertainty (which must be characterized and analyzed) and is conditioned on various factors (such as question phrasing, information considered, assumptions) (Warwick Manufacturing Group, 2007).[1]

During the implementation of the SCENT participatory methods, including Questionnaire Interviews (QI) and Focus Groups (FG), a list of stakeholders was gathered, which was afterwards classified based on the following criteria:

A. Geographical coverage:
   a. Local,
   b. Regional,
   c. National,
   d. International;
B. Type of Stakeholder based on the general structure of a Citizen Observatory:
   a. Citizen/Volunteer,
   b. Sensor Platform and Remote Sensing expert (SPRS),
   c. Modeller (MOD),
   d. Civil Protection/Operational,
   e. Policy Decision Maker (DMS);
C. Phases of involvement in floods monitoring and management:
   a. Preparation (pre-planning),
   b. Warning and activities during floods emergency (mitigating immediate risks),
   c. Resilience/Recovery (a longer-term activity of rebuilding, restoring and rehabilitating the community);
D. Data Analysis:
   a. User,
   b. Data Collection Operator,
   c. Developer/Modeller.

For both pilots, the expert judgement and aforementioned classification was conducted for all SCENT stakeholders who are involved in the process of flood monitoring and management.

2. Key Performance Indicators for evaluation of the SCENT Citizen Observatory

As a preparation for the focus groups, the SCENT consortium partners compiled a preliminary list of Key Performance Indicators (KPIs) that are considered important to evaluate the success of the demonstration campaigns, the project impact and the acceptance of the SCENT toolbox from the user

[1]Warwick Manufacturing Group, 2007 Elicitation of expert judgement: http://www2.warwick.ac.uk/fac/sci/wmg/ftmsc/modules/modulelist/peuss/slides/section_10a_expert_judgement_notes.pdf

perspective. These are not strictly technological KPIs, they are indicators from the SCENT stakeholders' perspective as to the acceptance of the SCENT solution during the pilots and to the impact of the project in general.
Stakeholders have provided their feedback for these KPIs, have proposed some new indicators and the consolidated the list along with a rating of importance as presented in Table 1.

Table 1 Key Performance Indicators evaluated and/or proposed by SCENT stakeholders

Description of KPI	Importance[2]
Number of participants in the pilot campaigns	1
Area covered by the pilot campaigns	1
Clarity of guidelines before and during the pilot campaigns	2
Number of Twitter, Facebook or other social media followers	3
Unique SCENT website visits	2
Number of players of SCENT serious games	2
Number of returning players of SCENT serious games	1
Overall satisfaction in SCENT serious games	2
Number of images sourced during the pilot campaigns annotated through the SIE	2
Number of images sourced during the pilot campaigns annotated manually (by gamers)	2
Number of open platforms/repositories images annotated through the SIE	2
Number of open platform/repositories images annotated manually (by gamers)	3
Update rate of improved LC/LU maps (with crowd-sourced data) for the pilot regions	2
Average time from crowd-sourced data submission (eg image, text) to updated flood risk / flood pattern maps generation	1

3. Ontological Analysis

Gruber in 1993 defined ontology as "an explicit specification of a conceptualization." Later, in 1997 Borst said ontology is "a formal specification of a shared conceptualization". According to Borst, besides explaining the ontology, conceptualization should express a shared vision among the parties; it should be seen as an understanding rather than individual opinions expressed in a common and accessible language.(Gruber, 1993) Studer, Benjamin and Fensel have combined these two definitions in 1998 and described ontology as a "formal specification, an explicit sharing conceptualizations." Since the mid-1990's research has been focused on understanding the context of ontologies in terms of an aspect or discipline, formal consensus on the specifications of concepts, relationships, attributes or ontology axioms that they provide.(Studer et all, 1998)

In this case, the ontological scenarios combine information from the discipline of anticipative information, looking at a European level on the concept of Citizen Observatories and Flood Risk Management (FRM) with local information (with perspectives from Sustainable Development Strategy for the Danube Delta) towards their integration into the hydraulic scenarios used in flood risk management activities.

The purpose of the proposed methodology is to create integrated scenarios into ontological complex network of global trends by adapting them to local conditions and to promote the concept of Active Citizen Participatory (ACP). The best way to approach the ontology of the flood risk management system interactions with the land use issues, is to use the systems theory approach.

Systems thinking basically means that we try to gain a better understanding of something by reflecting on the interactions of the crucial factors that define it. We look at a system in a so-called model.

[2] (Scale 1: very important, 2: somewhat important, 3: not really important, 4: not important/not relevant)

Systems theories should help us to come up with a useful model. As George E. P. Box noted: “Every model is basically wrong, but some are useful”. There are numerous fields of systems theory, ranging from cybernetics and systems psychology to systems engineering and systems biology. Also included are concrete principles that should describe how systems work (Neuman, 2013)

Today’s decision makers seldom use tools. There are several reasons for this. Some fear transparency, many don’t know that there are methodologies and tools available to them and others simply don’t understand how to use them. Most of us shy away from making the effort it takes to reflect on the complex challenges we are faced with. If best practices always worked when we applied them, everything would always be successful to the same degree (Neuman,2013)

Using the systems thinking modelling for the ontological analysis and the expert judgement approach, the Danube Delta National Institute (DDNI) team developed an example for Danube Delta case (thus the application of this methodology was performed only in the context of the Danube Delta pilot) from which all the valuable points in the flood risk management procedure can be extracted, so that the ACP could fit perfectly in the system. The team developed 2 tables for Ontological analysis that try both to organize the process of activities which contribute to the functioning of the CO system / Floods system, and to structure the 3-phase constituent of the Flood Risk Management: Training, Event, Post-Event. Filling these matrices was made following the EJ analysis described in the previous section based on the experience of specialists, as well as selected bibliography. These included evaluating relationships and the impact of factors.

RESULTS

In the general topic of flooding Danube Delta scenarios, coupled with the policies the European Environment Agency (EEA), ontology analysis is the bridge from global trends outlined in "State and outlook of the environment report" - SOER 2015 to integrating them into concepts ACP and CO locally (Figure 1). In this manner, the ontology of the flood risk management system in the European context gathers the relevant information creating the basis of knowledge about the relationship between activities in all the flood event phases. The ontology also develops the key in calibrating all data and procedures towards a better understanding of the pressures on ecosystems, giving it the dynamics necessary in the adaptation of the calibrated model (connections in black, dynamics- green line in the conceptual model).

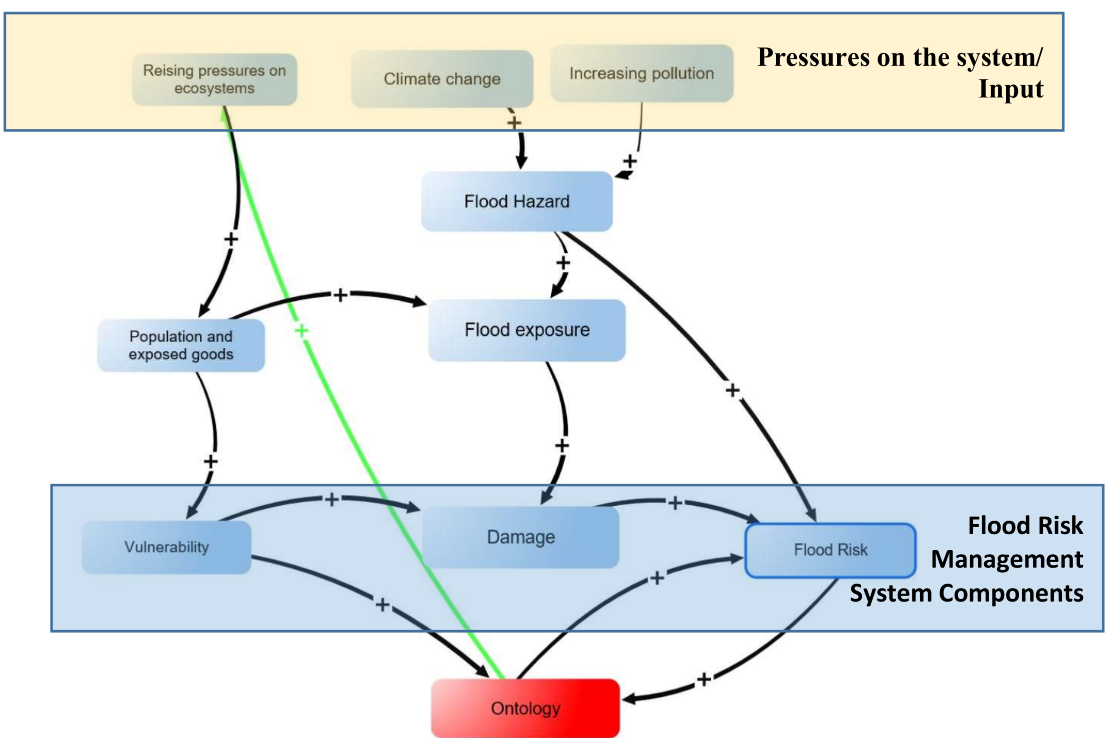

Figure 1 Hydraulic Scenarios into Ontological Analysis in Danube Delta (Nichersu, 2016)

- **Pressures on ecosystems**: In recent years, in Danube Delta there has been a development of residential areas in localities such as: Crisan, Mila 23, Saint George, Sulina. Continuous building of residential areas, requires strong action from local councils and all responsible institutions.
- **Increasingly serious consequences of climate change:** Climate change phenomenon has a globa recognition and also has a direct impact on the Danube Delta area. In particular, the frequency of droughts alternate with torrential rainfall led to unprecedented changes of the Danube discharge. Only the damage of the floods in 2010 reached 90 million euros at Tulcea county level. From a historical perspective, taking into account the historical measurements, in the 1970's floods, in the area of Vulturu village, led to the dismantling of an entire village. Sulina canal banks are affected by vessel traffic, but also the phenomenon of natural erosion, which increases the risk of flooding of settlements and its touristic infrastructure and lead to an increased volume of sediments discharged into the Black Sea. These vulnerabilities are exacerbated by climate change phenomenon, heavy rains in recent years leading to historical discharges of the Danube River, fragile ecosystems and endangering the human communities life in the area.
- **Increasing pollution:** Danube Delta is a paradise for wild fauna lovers (especially for the ornithologists), hosting over 300 bird species and 133 fish species. The Biosphere Reservation is in the 3rd place in the world, regarding the biodiversity level (over 7.400 flora and fauna species). Considering the morpho-hydrographical configuration, the fauna's and flora's association, the human-induced activities developed in the area, in the Reservation, were identified 23 natural ecosystems partially modified by human (flowing water, standing water, brackish, salty, lagoons, coastal marine areas, wetlands, forests, shrubs and herbaceous vegetation, areas with low vegetation or no vegetation, etc.) and 7 ecosystems (agricultural areas, fish farms, forestry setups, poplars plantations on river banks, urban and rural settlements, etc.). (SDSDD,2016)

The exercise is intended as an ontological boundary, detaching from the total reality the possibilities of developing the CO concepts, on Flood Risk Management (FRM) in the Danube Delta, which are subjected to scientific investigation.
Based on the ontology system analysis of the flood risk management system, DDNI team prepared a list of components from the main inputs identified and presented in Figure 2 and Table 2 and a list of activities for each phase in the flood event (see Table 3). Then, using the Expert Judgement method, the experts and end-users were requested to fill in the two tables provided below:

Table 2 Interactions of the identified activities within the flood risk system- Example of one completed table

Please, specify the importance of the column into the raw from the table on a scale of 0 to 10, where 0 represents the absence of importance, and 10 means the highest importance!
Example: The role of Data Collection into the Development (sensors) on Flood Risk Management.

	Data Collection (water Levels, Discharges, Land Use Changes, Infrastructure)	Development (sensors)	Smart Applications Creation / Serious Gamming (on Floods)	Remote Sensing	Modelling (DTM, DEM, 1D, 2D, 3D)	Decision Making (local, regional, national)	Research	Awareness	Administration	Volunteers
Data Collection										
Development (sensors)	10									
Smart Applications Creation/Serious Gaming (for Floods)	8	1								
Remote Sensing	10	4	2							
Modelling (DTM, DEM,	9	8	9	9						

1D, 2D, 3D)									
Decision Making (local, regional, national)	7	9	4	2	1				
Research	9	10	10	9	10	9			
Awareness	4	4	4	0	0	10	8		
Administration	5	6	1	1	1	10	8	0	
Volunteers	3	1	1	2	1	5	5	9	5

Table 3 Activities which contribute to the functioning of the CO system / Floods system (average from completed tables)

	Pre Event Phase			During event			Post Event Phase	
	1	2	3	1	2	4	2	4
Data Collection (water Levels, Discharges, Land Use Changes, Infrastructure)	4	5	5	5	5	1	3	1
Development (sensors)	5	5	1	4	5	1	2	1
Smart Applications Creation/Serious Gamming (on Floods)	4	4	2	4	5	5	4	1
Remote Sensing	2	1	3	1	1	1	2	4
Modelling (DTM, DEM, 1D, 2D, 3D)	3	5	5	1	4	5	1	3
Decision Making (local, regional, national)	5	5	5	3	5	5	5	5
Research	3	4	5	3	3	1	5	3
Awareness	4	5	5	4	4	5	5	5
Administration	4	5	5	5	5	5	3	4
Volunteers	2	4	3	4	5	5	1	1

Activities in the Pre-event/ during the event/ post event phases	
1	**Monitoring: Full Time Water level, flow, temperature (state infrastructure elements)**
2	**Communication / Notification / Alert / Alarm**
3	**Preparation: Plans, scripts, Recognition exercises**
4	**Intervention decision, evacuation**

After collecting data by the experts, the "map" factors were drawn and the relationships between them in the system using the program iModeller from Consideo GmbH (Figure 2). The result is represented by causal diagrams (or 'spaghetti' diagrams, so named because of their very complex appearance).

Figure 2 Ontological conceptual model extracted from

Table 2 reflects the system functioning and offers a general idea where the main components of the CO could very well fit into the flood risk management system structure.

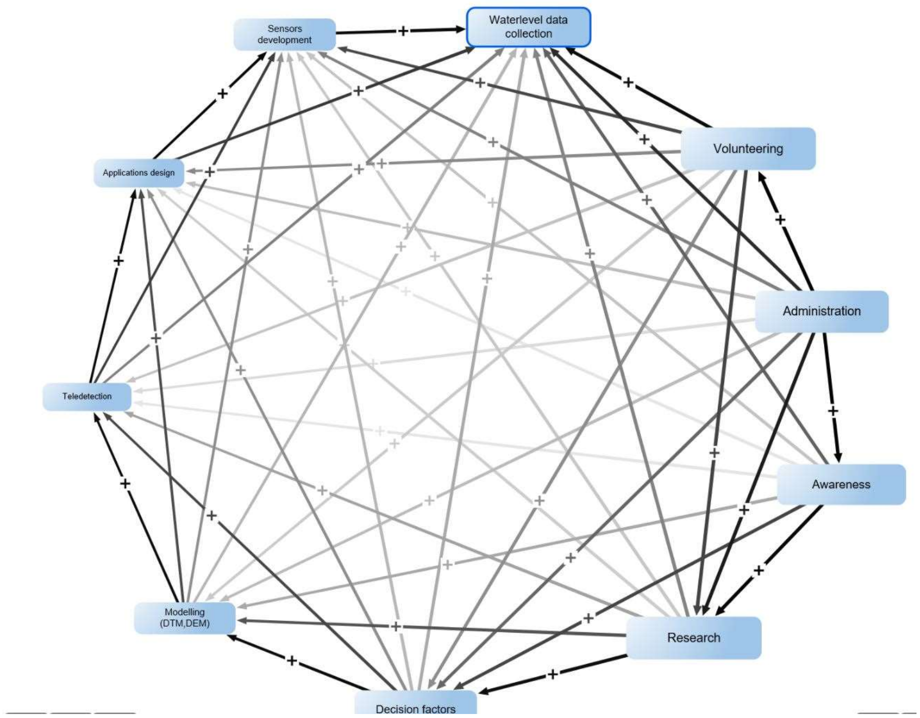

Figure 2 Ontological conceptual model extracted from

Table 2

Going one step further, Figure 3 reflects the activities interactions with the main components of the CO in the system functioning in the specific context of the flood phases (in this example, the pre-event phase). Each line reflects the information collected in the previous tables (thick line means a high influence, while a thin line reflects a low influence between the components).

In this study, factors and connections are not just a series of predefined views of gained knowledge by experts, it represents the result of a combination for the calculated assessments by experts in various fields in order to obtain new insights and a deeper understanding of the complex challenge for the deltaic system in the context of resource management. The approach is comparable to the theories of qualitative research where scenarios of possible developments of resources cannot be based only on empirical data collected in the past.

CO in Flood Risk Management can be considered as an ontological process, reflecting on the one hand, relations between its components, and on the other hand, the interdependence between this process and phased structure in which it is conducted. Local and regional community initiatives contribute to the integration of CO components, in the existing system of FRM.

Understanding Flood Risk in terms of disciplines and CO towards a consensus on formal specifications of concepts, relationships, attributes or axioms can be provided in the context of ontologies. In this case, the ontological scenarios combine information from the disciplinary anticipative at the European information level with the local information level (with prospects of Sustainable Development Strategy for the Danube Delta) for integration of these with the hydraulic scenarios.

But the integration of the CO activities in hydraulic scenarios regarding flood risk, socio-economic development is an interdisciplinary issue which will increase the effects of improving the activity of FRM, both in terms of climate change by enhancing events and the point view of anthropogenic component affected by flooding.

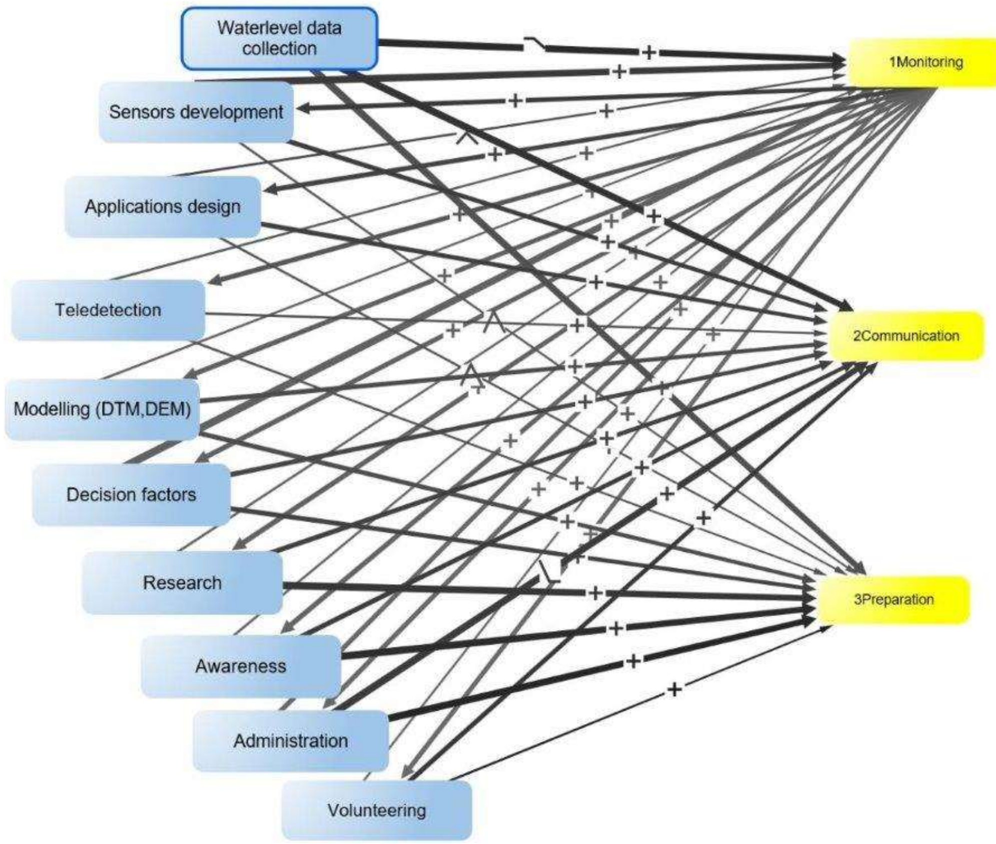

Figure 3 Ontological model of the FRM phases extracted from table 3

On the other hand, ontological analysis of CO / FRM in the Danube Delta also integrates the positive benefits of floods, which can be determined only by ACP with hydraulic scenarios, considering the need to restore the natural circulation of water in areas with sensitive habitats. This will be integrated in the future both in initiatives related to Flood Risk Management and related CO issues.

Consequently, ontological analysis is concerned with the inner workings of the integration process FRM / CO ensuring its balance. For example, the accelerated pace of development of remote sensing requires increasing the amount of taxonomic knowledge, to be transmitted in the modelling process.
If this increase is not related to the organization of modelling process, in another way of the process, then a disturbance is noticed.

Finally, the main issues that concern the ontological analysis could be summarized as follows:

- The content of the collected information.
- Technological development in the CO / FRM
- Ensuring a functional balance between the existing FRM system and CO components.
- Efficiency rating.
- CO Management / FRM Management.

CONCLUSIONS

This study serves as a reference documentation for the benchmarking of the monitoring schemes that are available and will be also applied during the implementation of the project, describing mainly the existing monitoring infrastructure as far as the hydro-environmental parameters of Danube Delta (Romania) and Kifisos (Greece) is concerned. Additionally, it describes the proposed pilot areas both in terms of general historical information as well as their specific objectives within the SCENT project scope. These mainly involve the existing and proposed scientific monitoring approach (incorporating continuous measurements with in-situ installed sensing equipment) as well as the volunteer measuring campaigns (incorporating typical examples of gathered information from citizens essential for the flood phenomena).

The deliverable also provides a detailed Experts Judgement Assessment, using important feedback from the involved stakeholders and end-users of both study sites as far as the success of the pilot campaigns and the overall project impact are concerned. The ontological analysis is also found essential for the critical analysis for the existing pressures that are applied on both water systems pilots of SCENT project, that also govern the flood management process as a whole.

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