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Public discourse and government action in a controversial water management project: the damming of the Aposelemis River in Crete, Greece

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Abstract

The politics and practices of decision-making in a large dam project on the Greek island of Crete is investigated through the case study of the Aposelemis Dam, a European Union (EU)-funded development project to supply drinking water to three urban centers and major tourist destinations. Our study employs a modified version of the World Commission on Dams (WCD) evaluation framework. We compare the processes used in Greece with the best practices suggested by the WCD framework. Our study reveals three areas of weakness in this project. First, the political decision to build the dam took place in the absence of reliable hydrological studies and in the face of strong opposition from the residents, local governments, and professional organizations. Second, during the stages of planning, design, implementation, and operation of the project, the Greek government failed to follow transparent procedures in its deliberations. Affected residents and local governments in all the stages of the project were disregarded and mitigation of negative effects was negligible. And, third, the comprehensive sustainable regional development goals of the EU funding were never materialized.

Keywords: Dams; Local/regional development; Public participation; Water politics; Water projects; World Commission on Dams

1. Introduction

The cultures and populations that have inhabited what is today Greece have a more than 4,000-year legacy of innovative water management in an arid and ecologically sensitive land (Angelakis *et al.*,

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2016). Today, however, most of this has been forgotten or abandoned in favor of top-down, technocratic solutions that tend not to work with nature or local economic and social conditions. Greece has strayed from successful past lessons and fallen into a top-down national level bureaucracy that is driven by a purely supply-side stance on water resource management (Mylopoulos *et al.*, 2003). This case study of the Aposelemis Dam, in Crete, corroborates this observation with reality.

The Aposelemis watershed in Crete is a good example of a water-rich location on a water-challenged Greek island (Figure 1). This area has nourished diverse civilizations (Minoan, Roman, Venetian, and Ottoman) with an intricate system of water management that could support significant agriculture for local consumption and export that has been able to react to drastic climatic variations for over 4,000 years (Markonis *et al.*, 2016). Because of this water, the valley is famous for high-quality olive oil and numerous other fruits and vegetables. It was part of the 'bread basket' of the Venetian empire. This dam has turned this valley into a remote source of water to supply growing tourism and urban population demands in the surrounding coastal region, including the towns of Heraklion, Hersonissos, and Agios Nikolaos.

On the island of Crete, water resources are unevenly distributed, resulting in the island being overall dry. Water demand is also skewed, with the coastal areas having a high demand due to major urban centers and extremely high levels of tourism. Western and central Crete have relatively abundant water resources, while in eastern Crete, these are limited (Figure 2). Many of the northern coastal water resources are suffering from salt-water intrusion. Meeting water demand has for decades occupied both the central government and the local authorities, particularly the towns and tourist centers of Heraklion and Agios Nikolaos. The recent expansion of tourism infrastructure and superstructure in these two regions has created increased demand for water resources. But instead of proceeding with the execution of a regional management of all water resources on Crete, the government chose to proceed with the 1970s solution to construct a single large dam on the Aposelemis River, to address the acute problems of water supply of Heraklion, the largest city of the island (Greek Statistical Authority, 2012).

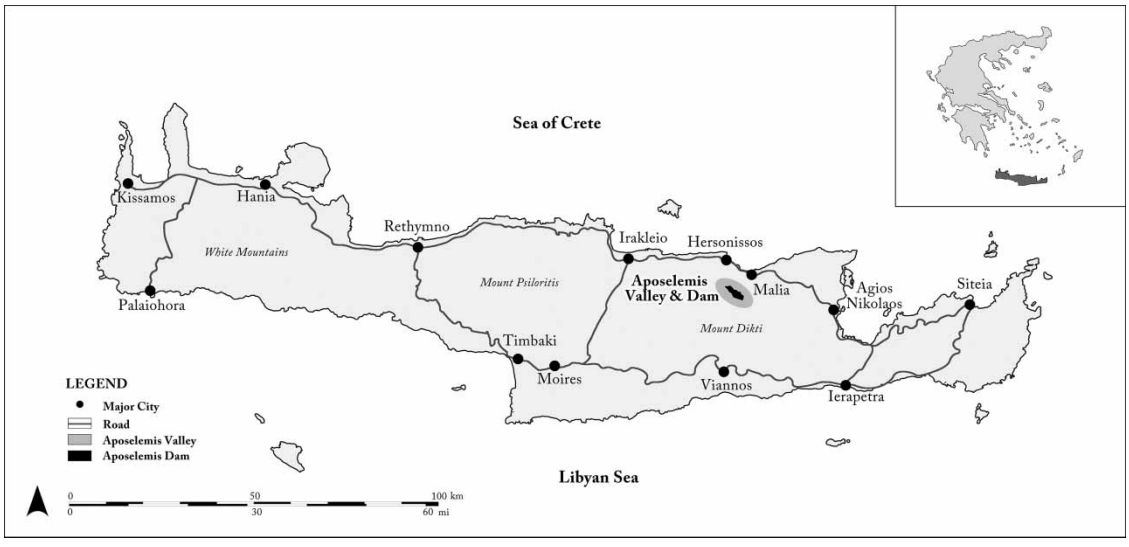

Fig. 1. Location of the Aposelemis Watershed on Crete, Greece.

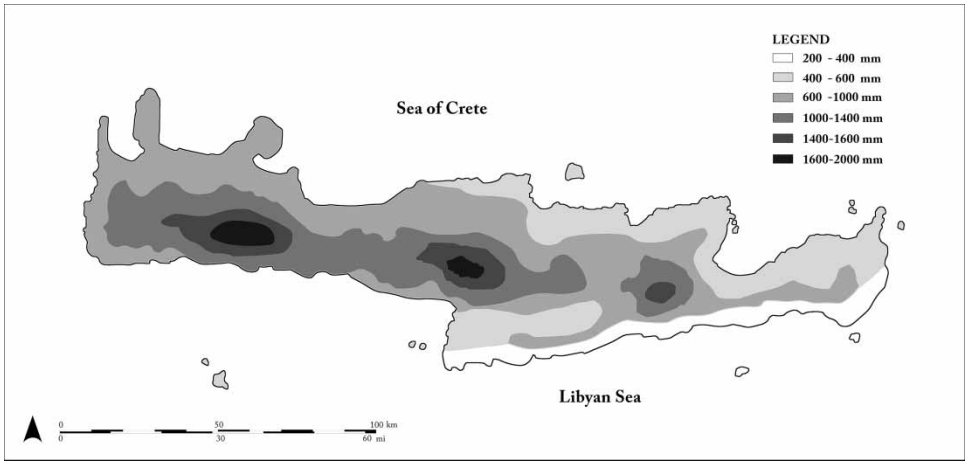

Fig. 2. Annual precipitation in Crete.

This paper looks critically at the Aposelemis Dam project, construction of which spans the period from 1972 until today, as a case study of the largest water management project to be instigated in Crete. This paper is unique in that it is based on years of observation, interviews with decision-makers and stakeholders, access to primary resources, including correspondence and reports, as well as local news coverage. We take these disparate data and synthesize them in order to understand and explain what happened over the 46 years of this project. This paper focuses on the analysis of the procedures followed in the decision to build the dam, and those practiced during the various phases of the project in order to determine if and how the development of the local region was taken into account. We assess if and how they responded to European Union (EU) and Greek directives for such projects, as well as benchmark against the World Commission on Dams (WCD) definitive study on guidelines for smarter practice published in 2000. This case study juxtaposes the 46-year timespan of the project with an era in which the views on large dams and water resource management have been evolving and codified in new ways worldwide. Our analysis reveals the complexity and pitfalls of current water resource management practices in Greece, points out where the process was problematic, and provides insights as to why.

2. Literature review

The analysis of our case study takes into account four dimensions of shifts in water management planning and governance that were occurring during the 46-year span of the project. The EU changed its philosophy and expectations for water management that required major shifts in state and local approaches. Greece was barely reconciling its own outdated and centralized approaches to water planning and management with expectations. Additionally, the state of large dams in the United States and Europe shifted dramatically, placing the construction of the Aposelemis Dam at the cusp of shifts in best practices. The rise of the WCD in the late 1990s and their extensively researched guidelines was also influential in the reassessment of the relationship of large dams with local and regional development. These are all briefly discussed in this section providing an overarching context for the case study.

2.1. Water resource management in the EU and Greece

To address the unsystematic treatment of water issues, the EU re-conceptualized and reorganized water management under the Water Framework Directive (WFD) in 2000. This Directive established unified policy guidelines integrating water quantity, quality, ecology, water use, and disposal and emphasized the procedural side of good water management. It created new management bodies to match river basin districts and integrated planning of water resources and use. Water issues could no longer be considered in a vacuum and had to consider public participation, economic analysis, and related policies (Boeuf & Fritsch, 2016).

Progress in reaching desired WFD outcomes in Europe has been slow, mostly because its shift to a systems approach does not align with most government structures (Voulvoulis *et al.*, 2017). Studies show that Greece has had a particularly slow harmonization and compliance of its legislation with the guidelines and directives of the WFD (Podimata & Yannopoulos, 2013). The Water Resource Management Plans required by the WFD tend to be difficult to implement in Greece due to insufficient and contradictory data and a lack of political will to take the plans seriously.

Despite the EU-imposed Directive, Greek water policy has tended to focus on finding new and often remote water sources instead of improving infrastructure and efficiencies, considering water conservation, or exploring innovative solutions (Bithas, 2008). Alternative options such as desalination, water recycling, and rainwater are not taken seriously (Gikas & Angelakis, 2009). In Greece, water resources belong to the state making it difficult to achieve decentralization of water management decision-making, despite attempts at decentralization to the regional and local levels. Local water companies, which became semi-private entities in 1999, in practice, have very little power regarding water decisions.

The Greek legal and institutional structures for water management are complicated, disjointed, conflicting, top-down and very political in nature (Kampa & Bressers, 2008; Podimata & Yannopoulos, 2013). Updates of legal frameworks regarding water have been slow and still leave a plethora of old often conflicting laws on the books. Laws are confusing and even contradictory, assignments of responsibility are unclear, national and regional planning is slow and systematic collection of data on water resources is inadequate (Gikas & Angelakis, 2009). Much of what goes on in the water sector are turf and power struggles among institutions and government levels, while the concerns in these struggles are usually not about water/environmental/human issues but rather about resistance to change and preservation of the status quo (Podimata & Yannopoulos, 2013).

Participatory initiatives in Greece are inadequate, due to its centralized and hierarchical structure of governance, weak civil society sector, and no culture of consensus building (Demetropoulou *et al.*, 2010). In a review of participatory practices in water management in Greece, it was found that required participation was weak, extremely administrative-sided, and done late in the process so there was no real possibility to influence decisions. Additionally, communication between scientists and technocrats is poor, resulting in water management decisions that emphasize the views of the technocrats, giving almost no credence to environmental/ecological issues or local economic or social development concerns (Videira *et al.*, 2006).

The WFD does not directly deal with dam planning, but, because dams concern water resource management, the Directive guides the processes and factors affecting the decision-making process of dam projects within EU. About 7,000 large dams exist in Europe. By the late 1990s, dam construction in the EU was almost zero, a trend that resembles a similar large dam construction decline globally (European Environment Agency, n.d.).

2.2. State of large dams

The era of large dams started in the late 1880s and by 1975, most large dams in the USA, Canada and Western Europe had been completed (Shah & Kumar, 2008). Yet, already by the mid-1960s, burgeoning environmental movements and the rethinking of development practices began to question their negative impacts and triggered the exploration of alternative solutions. The late 1990s saw movements in the USA to restore rivers by either altering or demolishing dam structures, as part of a wave of rethinking water resource management techniques. Some of this 'turning away from dams' was also economic. Dams have high planning, construction, operating, and maintenance costs, especially as they age, making them financially risky long-term investments. Large dams have more costs and provide fewer benefits than was assumed (Lowry, 2003).

Decades of experience have also shown that the development intentions of dams are rarely met, especially in their immediate region. Reasons cited include the institutional structures to facilitate development targets are not put in place or applied, social and economic potential are often displaced, and ecological issues are often barely recognized (McCartney, 2009). In addition to inadequate early consideration of potential problems of dam projects, controversies often ensue, adding legal, social, and economic costs to the projects for years.

2.3. The World Commission on Dams

In 1997, the World Bank and the International Union for the Conservation of Nature hosted a workshop of government, consulting firms, academics, and NGOs in Gland, Switzerland, in an effort to comprehensively and effectively deal with the management of water resources. Their discussions eventually resulted in the founding of the WCD. In 2000, the Commission released its report, *Dams and Development: A New Framework for Decision-Making*, which is considered a landmark for guidance on sustainable practices (Scheumann & Hensengerth, 2014).

The report was never adopted as mandatory guidelines, and some even feel that it is impractical as a real process (Briscoe, 2010). Nevertheless, it is fully compatible with the EU WFC, has been endorsed by the United Nations and many European governments, has been accepted internationally as the most important contribution on the planning, analysis, and decision-making procedures for large dam projects, and has influenced the planning process for dams (International Dams Initiative, 2004; Scudder, 2005). Since its release, it has been used by a number of scholars studying the impacts of large dams and has often been adopted as the framework for their investigations (Bird & Wallace, 2001; Andre, 2012).

3. Methodology

Our objective was to answer the following: How was the project conceived, planned, programmed, implemented? Who were the decision-makers and what were the key decisions driving what happened? Who were the major actors and stakeholders and what roles did they play? And, how did the process affect the objectives of increased water supply and local development?

We have investigated these questions using four mutually supportive sources of data and used these primary and secondary sources to triangulate the sequence of events, reactions, and outcomes. First, we

reviewed and assessed the established Greek project development and permitting regulations and procedures and determined how they have been applied in the planning, design, and construction of the Dam. Second, we examined internationally accepted standards and guidelines for large-scale water management projects codified by the WCD. Third, we examined official studies and documents related to the project, official correspondence and materials generated by stakeholders and responsible government agencies, and the extensive publicity on the topic by local, national, and social media. Finally, we combined these with our own documentation as observers–participants in the entire process of planning and implementing the dam project.

We adopt a modified analytical framework based on comprehensive guidelines proposed by the WCD in their report *Dams and Development: A New Framework for Decision-Making*. Focusing on decision-making for the provision of water and energy services, the report 'emphasizes a structured process incorporating the full range of social, environmental, technical, economic and financial criteria and standards' (World Commission on Dams, 2000, p. 259). This framework recognizes all stakeholders and institutions that can be affected by or can play a role in the implementation of large water containment projects. These include government, civic society, private sector, professional organizations, multilateral and bilateral organizations, international agreements, and international standards. Our study focuses on revealing the roles played by each of these entities.

The framework of the WCD consists of seven strategic priorities and criteria for five project stages outlined in Tables 1 and 2.

Our modified framework omits two of the strategic priorities, 'Address existing dams' and 'Share rivers for peace, development and security' as they are not directly relevant to this study. The Aposelemis project is isolated within the watershed on an island and has had no other large modern

Table 1. Strategic priorities from WCD framework.

Gain public acceptance of key decisions	Recognize rights, assess and address risks, provide access to information and legal support, negotiate agreements in transparent ways, and safeguard entitlements of affected individuals and groups.
Assess options comprehensively	Explore alternatives based on development needs and objectives for water, food (and energy, if applicable), and select the best option based on an assessment of all policy, institutional, and technical options.
Address existing dams	Optimize their benefits and/or improve their operations and performance, taking into account changes in water demand priorities, land use changes, and public policy changes.
Sustain rivers and livelihoods	Understand, protect, and restore affected ecosystems both with respect to ecological systems and human reliance on these systems for livelihood.
Recognize entitlements and share benefits	Negotiate with people adversely affected. Mutually agreed, legally enforceable mitigation, resettlement and development entitlements need to be the foundation of these negotiations.
Ensure compliance with regulations, criteria, and negotiated agreements	Meet all commitments made with the stakeholders. Prepare a Compliance Plan that spells out criteria, guidelines, and binding arrangements for technical, social, and environmental commitments.
Share rivers for peace, development, and security	Address storage and diversion of water on trans-boundary rivers, the use and management of water resources, and agreements between states for peaceful regional cooperation.

Source: World Commission on Dams (2000, pp. 213–257).

Table 2. Criteria for project stages from WCD framework.

Needs assessment: validate the needs for water (and energy) services
Ensure actual water service needs have been assessed locally and regionally, and advance goals and objectives of a broader development plan and program. Use participatory procedures to define development objectives and guide subsequent assessment of options.
Alternatives selection: identify the preferred plan among viable options
Prepare a range of alternatives reflecting needs and declared development objectives. Use a multi-criteria process that considers all policy, program, and project alternatives to select a preferred action plan.
Project preparation: verify that commitments are in place before tender of the construction contract
Define the conditions for the study and design of the project, including compliance with all mitigation and monitoring measures. Comply with all prior agreements, including all the environmental and social plans and development programs. Define the sequence and stages of resettlement.
Project implementation: confirm compliance during process
Implement processes that ensure all technical requirements and mitigating conditions agreed upon during the previous stages are included in the future operating agreements. This includes operations and all rules governing them, public notifications, dam safety, monitoring, and periodic review. Phase resettlement as the dam is constructed.
Project operation: adapt to changing contexts
React to the balance between 'development goals' and 'technical objectives' in the construction and operation of the dam. The development focus, as well as the environmental and social contexts under which the initial project plans were made, may change, and thus require that active monitoring of the operation, as well as all commitments made to all stakeholders are continuously updated.

Source: World Commission on Dams (2000, pp. 259–307).

water management projects. Therefore, we use a matrix of the remaining five strategic priorities and the five project stages as our assessment tool. Each of the priorities is used to systematically analyse each of the project stages.

4. Timeline of Aposelemis Dam project

4.1. Technical and cost data

The Aposelemis Dam is part of an integrated water supply system that includes pumping groundwater and retaining rainwater. It aims to provide an annual water volume of 20.4 million m^3, covering the increasing water needs of the broader regions of Heraklion and Agios Nikolaos and the municipality of Hersonissos up to the year 2035 (Aronis-Drettas-Karlaftis & Montgomery Watson Ltd, 1998). Technical details of the dam are shown in Table 3.

In 2006, the European Commission awarded Greece 114 million euros for the construction of the Aposelemis Dam (Kotsonis, 2013). Two years later, the project budget had increased to 156.9 million euros (see Table 3 for breakdown of costs) (Kavvadas *et al.*, 2008), while the 2012 available estimates assessed total expenditures at 223.7 million euros (Agapakis, 2013). These expenditures as of 2012 include construction of dam and reservoir 38.7 million, refinery and pipelines 82 million, the Lasithi connector 47 million, supplemental construction 10 million, and 46 million for land expropriations. The construction costs alone are assessed at 177.7 million. These are the last published cost estimates but are not the final, because the contractors have not been fully paid and there are still uncompleted components of the project. So, since the start of the project, construction costs have gone up by 63.7

Table 3. Technical characteristics (Kavvadas *et al.*, 2008).

Component	Details	Data and specifications
Hydrological potential	Watershed area: 143.0 km^2 (62.4 km^2 Aposelemis River plus 80.6 km^2 Lasithi Plateau). Rainfall in the region varies widely from year to year, often registering zero. Average annual rainfall: 800.6 mm.	Over a 25-year observed period, average water collection potential of the watershed is 9.5–11 million m^3
Dam and reservoir	To be filled primarily from the Aposelemis torrent. Construction began in June 2005 was completed by June 2013.	Crest length: 660 m Height of embankment: 62.5 m Width of base: 320 m Reservoir capacity: 27.3 million m^3 Level of crest: 224.5 m Overflow level: 216 m Highest water flow level: 214 m Lowest water flow level: 184 m Basin area: 1,599 streams (approximately 400 acres) Projected annual water supply volume: 17 million m^3 Budgeted cost: 27.9 million euros
Lasithi Plateau Augmentation Works	Dam water to be enhanced by the runoff of the High Plateau of Lasithi catchment area. Construction began in May 2012, completion expected by end 2018.	Budgeted cost: 47 million euros
Water transporting pipelines and water refinery	Transporting the Aposelemis water to the refinery, and from there to the cities of Heraklion and Agios Nikolaos, 6 other municipalities and 19 communities. Refinery is complete and in operation. Pipelines began in October 2006, completed by December 2015.	Supply pipeline: 74 km. Budgeted cost: 82 million euros

million euros. Regarding the operation of the dam and water refining and distribution, it was estimated by the Aposelemis Consultants Collaborative (2003) that the system working at full capacity would cost 2.8 million euros annually. In 2018, operating costs were 1 million euros (for 7 million m^3 of water, 13.4 million m^3 below the projected annual water supply capacity) (Mamagakis, 2019).

4.2. Formulation (1960–1999)

The possibility of constructing a dam in the Aposelemis watershed to solve the pressing water needs of the growing city of Heraklion was first discussed in the 1960s. The city population increased rapidly, especially since the influx of tourism by the mid-1970s, going from 77,506 inhabitants in 1971 to 95,150 in 1981, to 146,536 in 1991 to 163,115 in 2001, and to 173,993 in 2011 (Greek Statistical Authority, 2012). In 2017, the city was declared the fastest growing tourist destination of Europe. Actual plans for the dam were conceived by 1972. By then, the assumptions that shaped the project were already antiquated.

The first exploratory study for the supply of drinking water to Heraklion was conducted by the prefecture in 1972 and was followed by a series of technical studies (from 1977 to 1998) specifically focusing on the waters of the Aposelemis River, with the intention of supporting the construction of a single large dam to collect this water for distribution. Conducted by the Heraklion Municipal Corporation for Water and Sanitation and by the central government Ministry of the Environment, Physical Planning, and Public Works, these studies focused on engineering and hydrological issues, including one on the project's environmental impacts (in 1993), and were conducted in virtual secrecy.

However, information about the planned project was leaked by the mid-1990s, triggering several reactions. In 1995, the University of Patras Department of Geology and Center for Hydrology conducted a study of water resources and management in the region commissioned by one of the local non-profit development organizations. That study recommended a major update of the data on the water quantities in the Aposelemis watershed to obtain an updated estimate of the water supply ability of the watershed; and proposed replacing the large dam with a number of small collector dams along the course of the river. This alternative would retain the rainwater to the maximum extent possible, would continue to replenish the underground water aquifer, and would minimize the danger of underground seawater infiltration. This alternative could be accomplished at only a small fraction of the enormous estimated cost of the large dam and its facilities (Kallergis, 1995).

4.3. Opposition (1999–2002)

The Hersonissos municipality, alarmed by indirect information about a large dam being funded in its territory that surfaced in 1999, officially demanded information from the consultants about the proposed project. That information did not become public knowledge until September 12 of that year, when the residents of the villages owning property in the valley were first informed about expropriation and proposed compensation prices for their properties through an article in the local newspaper *I Tolmi* (Manousoudaki, 2000). The opposition was immediate. The period from September 1999 to the end of 2001 was marked by feverish activity by the project's opponents. In numerous meetings of the organized opposition of residents with local and regional authorities, efforts were launched to (a) stop the project, or (b) modify it to a smaller footprint and reduced environmental impacts, (c) secure fair compensation for expropriated properties, and (d) if all else failed, ensure the organized relocation of the Sfendili residents to a new settlement.

Levels of compensation were to be court-determined by November 2000 but were released in July 2001. In preparation for the court hearings, meetings were organized by the local government with the participation of residents from Sfendili, Potamies, and Avdou – the three villages directly affected by the dam – and residents from the Lasithi Plateau who owned holdings of olive groves in the Valley. The result of these meetings was that the Sfendili residents reluctantly accepted the necessity of the dam and would resettle in a new village, to be planned by the Ministry and located somewhere in the region. It also became clear that there was no recourse for higher compensation for their land, much of it productive farmland.

Ministry officials were clear that under no circumstances would the project be cancelled or modified, since the European Cohesion Fund had already approved the project's funding based on its water collection estimates and its environmental implications (Bogdanidis, 2000). Nevertheless, in December 2000 and January 2001, the Avdou and Potamies residents appealed to the Council of State petitioning the cancellation of the project. Their petitions were rejected in 2002.

Early in 2001, an 'angry' Secretary of the Ministry of Public Works, in 'tough and severe terms, ordered' the procedures for the implementation of the project to be accelerated, and threatened that if any opposition to it continued, he would divert the 60 billion drachmas (221 million euros) from Crete to another region (Bogdanidis, 2001). This paternalistic attitude was indicative of the manner in which the central government dealt with the opposition to the project.

In 2001, residents appealed to the European Commission charging that the environmental impact assessment for the project did not consider either the NATURA2000 status of the Lasithi Plateau or the CORINE Biotope status of the river estuary. No action resulted from this appeal.

In mid-2002, the National Technical University of Athens completed a hydrological study of the Hersonissos region that had been commissioned in 1996. That study found that the water on the northern edge of the Aposelemis aquifer already shows partial salinity, that the river course is chiefly responsible for the maintenance of both quantity and quality of water in that aquifer, and that the construction of the dam would 'contribute to the complete destruction' of this aquifer. It urged construction of small intervention dams along the course of the Aposelemis to retain its winter waters and allow them to replenish the aquifer, proposed incentives to encourage exploration of alternative water supply sources, and recommended drilling deep wells with devices installed that would stop pumping water as soon as the increase in chlorides would be detected (Kallergis, 2002). No one considered this study.

Also in 2002, the affected municipalities of Hersonissos, Malia, and Gouves commissioned the National Technical University of Athens to evaluate the water estimates of the Aposelemis watershed. That study found that 30–40% of the watershed – an average annual water volume of 5–6.5 million m^3 – is contributed by the Lasithi Plateau (between 41% and 68% of the total Aposelemis flow in winter). Of that, 4–6 million m^3 must be retained for Plateau irrigation (The dam project does not recognize any such needs). As such, the total water annually available for use in the reservoir is 9.95–11.4 million m^3 instead of 22 million. It also warned that the village of Potamies, in close proximity to the dam, would be immediately flooded and submerged in the event of a catastrophic dam failure (Tsakiris, 2005).

Simultaneously, the Chamber for the Environment and Sustainability issued a report assessing the environmental feasibility of the dam. Its findings again concluded that the dam would not have enough water to solve the water supply problems of the cities of Heraklion and Agios Nikolaos (because its annual rainwater collection varies dramatically, on some years being zero), while the project itself did not respect the principles of comprehensive water resource management for Crete. The report condemned the dire environmental implications of the dam for the Plateau, the Valley, the course of the river north, the biotope at the estuary, and the quantity and quality of water in the Aposelemis aquifer (Chamber for the Environment & Sustainability, 2001).

4.4. Construction and operation (2002–2018)

Yet, in spite of all the opposition by the public and the scientific community, by 2002, the project was well on its way with expropriation of property completed. Initial work included clearance of trees from the reservoir basin, production of gravel and other raw materials needed for the dam, arrangement of the riverbeds feeding the reservoir with water, and construction of a new segment of the provincial road connecting Hersonissos to the Lasithi Plateau, to replace part of the existing road that would be submerged by the dam. Construction of the dam embankment began in 2005 (and was completed by 2013). A year later construction began on the treatment plant and the pipelines for water distribution (completed by 2015). In mid-2012, construction began on the augmentation works in the Lasithi Plateau, consisting

of a channel collecting the Plateau water and delivering it to the mouth of a 3.5-km tunnel cut through solid rock and transferring that water to the lower Aposelemis Valley. That project is still under construction, with expectations for completion in 2018. By 2015, the dam began supplying water.

5. Assessment of the dam project

This section benchmarks the project against the WCD guidelines. Each strategic priority in Table 1 is used to assess each project stage from Table 2.

5.1. Stages I and II: needs assessment and alternative selection

It is well documented that the water resources available to the north coast region of Crete are inadequate to cover all the needs of the local population and visitors (Ecological Intervention of Heraklion, 2006). Yet, no systematic study of water needs, options, and alternative management approaches was ever conducted (Papamatheakis, 2000; Staridas, 2001). Instead, proceeding with the project was a political decision of the central government, without attempts to gain public acceptance. In fact, it was shrouded in a veil of secrecy. However, as the engineering studies were conducted, they inevitably alerted the local stakeholders in the Aposelemis valley (Chamber of Environment and Sustainability, 2001).

The municipality, professional organizations, and the local communities immediately organized their opposition to the dam plans, including demands for less invasive alternatives (GEOTEE & TEE/TAK, 1995; Association of Greek Geologists, 2001). They argued that one of the most fertile, economically important, and beautiful regions of Crete would be sacrificed without considering any alternatives, such as the one already completed by the Organization for the Development of Eastern Crete (OANAK). That study proposed the tapping and separation of the underground waters of Almiros, west of Heraklion, that would provide a steady supply of fresh water to Heraklion at a small fraction of the Aposelemis Dam cost. Neither the study nor the advice of the organization was taken into consideration.

The consultants failed to consider alternatives to the single large dam, arguing in their technical study that such alternatives were not feasible (Aronis-Drettas-Karlaftis & Montgomery Watson Ltd, 1998, pp.12–13), even though already in a 1995 study, Kallergis emphasized the advantages of constructing smaller embankments along the path of the Aposelemis River (Kallergis, 1995). In its eagerness to secure the EU development funds, the central government simply chose to ignore this discrepancy in the consultants' plan.

Basically, during the project planning phase, no account was taken of the local economic and social impact of this major project. The compensation given for the expropriations was considered sufficient to address the needs and concerns of the local population, without recognizing that most of the expropriated land was productive farmland. The immense olive groves in the valley (upwards of 150,000 olive trees) were reduced by the expropriations, which cut approximately 37,000 olive trees and 15,000 miscellaneous other fruit, as well as other wild and ornamental trees (Ministry of Finance Heraklion Real Estate Service, 2005). So the local economy experienced huge losses and the high cost of property on the north coast of Crete would make it difficult for the displaced residents to obtain alternative housing in the region.

The government followed established rules regarding property compensation procedures. However, the absence of a cadaster for the region instigated many time-consuming lawsuits to determine

ownership, and in the end, benefited mostly the attorneys. In addition, unclear terms for the expropriation of property gave an unfair advantage to the tree removal contractor, who was allowed to move into the area just before the 35,000 olive trees were ready to be harvested, and harvested them himself – with the consent of the government – thus depriving the local residents of a year's income.

The valley is not the only affected area. The majority of the water estimated to flow into the reservoir would come from the High Plateau of Lasithi, 10 km south and 1,000 m above the valley. The Plateau is one of the most fertile regions of Crete, which developed a unique system of water management to support agriculture for thousands of years. The Plateau receives large quantities of rainwater and snow during the winter, supplemented by even larger quantities of melted snow from the surrounding mountains in the spring. That water floods its plain, replenishing its enormous underground aquifer. The surplus water is naturally directed to the Plateau's northwestern edge, where Honos, a natural cave tunnel, channels it to the Valley, forming the Aposelemis seasonal river. As part of the Aposelemis Dam system, all that water is now being channelized through a new 3.5-km tunnel, leaving the Plateau and its aquifer dry. These dramatic impacts on the Plateau were not considered until the residents of its villages forced the project to a stop, compelling the government to at least address their concerns. Even so, agricultural activity in the Plateau will be reduced, but there has so far been no assistance to the farmers so that they would be able to reorganize their lives to meet these new realities.

5.2. Stage III: project preparation

The consultants' studies focused primarily on the engineering design specifications and requirements of the project, while ignoring planning requirements related to the social, economic, and environmental issues and implications of the proposed dam. The legally required environmental impact statements were prepared and approved by the government in 1993, despite evidence of environmental issues. No socio-economic components were included in the impact studies. These studies were prepared without any interaction with the legitimate stakeholders, namely the local governments, the professional and civic organizations with an interest in dam issues, and the residents of the local communities affected. Public participation was solely the initiative of these stakeholders, who fought battles with the contracting agencies to gain information about the proposed plans. The four communities of the valley were especially active and loud in this respect, as their own existence as cohesive communities was being threatened.

As the dam studies progressed towards their final proposals, it became obvious that there were no alternative design options considered despite repeated attempts by the stakeholders to introduce alternative water management (Monopolis & Kleidopoulou, 2001; Tsakiris, 2008). The Aposelemis River was not considered a waterway of ecological or economic importance. Its original course was widened and drastically canalized, and portions of the river are channelled in tunnels. The original course of the Aposelemis, fed by the Lasithi waters through the natural 'Honos' cave, was abandoned and was replaced by an artificial 3.5 km tunnel channelling these waters to the reservoir via an alternative winter torrent. Neither mitigation nor enhancement of the existing ecology and landscape was considered by the plan, and none was forthcoming during its implementation. On the contrary, after the completion of the project, the Valley site now has the appearance of an unfinished construction area. Piles of debris are scattered everywhere and huge quantities of gravel, the byproduct of the extensive drilling into the mountain, are deposited all around the tunnel. The landscape is now criss-crossed with dirt roads originally dug to accommodate the movement of heavy earth-moving equipment.

There is no plan, nor the funds for landscape and environmental restoration. Moreover, there are no monitoring and evaluation processes to prevent further environmental damage.

Much permitting for approval to construct this dam was bypassed. The official proposal submitted by the Dam Implementation Agency did not contain certain permits and certifications required by law. Those included the permit of the regional Forestry Service office to build in a protected, forest-designated area and permission from the Ministry of Culture to build in an area of major archaeological interest.

5.3. Stage IV: project implementation

With no enforcement in place, neither the contractor nor the central administration attempted to establish monitoring of the construction phase. As part of the original management plan, a dedicated operating entity should be established, whose exclusive function would be to ensure the sound operation of the water system and the fair charging of its water. Instead, the decision was made by the central government to give that responsibility to the newly established Organization for the Development of Crete, formed from the consolidation of two previous agencies responsible for the development of Eastern and Western Crete (Ministry of Environment, 2013). No local stakeholder representatives were appointed to it.

No consideration of potential climatic changes, weather events, excessive rainfall, or its complete absence, or technical problems that might occur during the dam's operation. It so happened that the winters of 2016 and 2017 were unusually dry in eastern Crete, and that as a result, the dam's reservoir had only an estimated 2.7 million m^3 of water as of March 2018, with no expectation that it might begin to refill soon (Nikiforou, 2017; Makaki, 2018). In fact, the summer 2018 water management plans of the city of Heraklion did not even consider the Aposelemis reservoir as one of the sources of its water. They did finally have 7 million m^3 of the estimated 20.7 million m^3 capacity of the project for 2018 (Mamagakis, 2019), still quite a shortfall.

Lack of plans for downstream river releases disrupted the river's natural seasonal water flow. The fragile biotope of the river delta has been jeopardized, resulting in a small pond of shallow stagnant water that becomes a murky swamp in the summer.

The promises to create a prototype rural community in proximity to the reservoir faded for the residents of the soon-to-be-submerged village of Sfendili. The municipality of Hersonissos made a tentative agreement to secure land in an alternative location, make a general plan for a community, and build some public facilities. A topographical map of the chosen location was published and landowners in that location were invited to submit tenders for the sale of their land. However, most of the landowners mistrusted the government and felt they would make more profit selling the land themselves to the displaced residents. Whether it was the greed of the landowners, the incompetence of the government services responsible, or the change of heart of the municipality to go ahead with its plans, the result is that no resettlement community has been established or planned.

5.4. Stage V: project operation

The Aposelemis Dam water project has been in use since late 2015, so it is premature to analyze its performance, but already several issues have been identified. First, a major objective of the dam construction, besides the supply of drinking water, had been to trigger economic and social development

in the region. However, the developmental aspects of the project were never identified, and no attempt has been made so far to commission new studies that would explore the potential and new opportunities for development afforded by the presence of the dam and its reservoir. Additionally, two critical issues of local concern, the irrigation of their farmland and the completion of the sewerage treatment facilities in the villages, have not been addressed. As yet, there are no irrigated fields in the Valley, and there seem to be insurmountable problems for the village sewer plans and treatment facilities to be implemented.

In the Lasithi Plateau, because of the drastic changes brought about by the channelization of its waters to the reservoir, a rural development plan that would propose new cultivations and new markets for the local products was supposed to be prepared. No plan has been produced so far.

No comprehensive monitoring and evaluation program of the technical, social, and economic parameters of the project exists. Stakeholders have not been kept informed about the details of the operation and any contingency plans given the shortage of water in the reservoir. These are issues of grave concern to the stakeholders, who anticipated participating in a comprehensive project evaluation.

6. Findings and discussion

Our analysis identifies and assesses the processes used from conception to operation of the Aposelemis Dam project. This assessment points to a less than desirable outcome to date with respect to local and regional objectives and expectations. We found that the project fails to meet most of the criteria of the WDC guidelines and similarly fails to align with the spirit of the EU WFD. The neglect was fourfold: (a) it did not consider the water management objective of the project within the broader context of water resources management in Crete, or even eastern Crete; (b) it missed the opportunity to implement a sustainable regional economic and social development project, as originally claimed; (c) it went through the stages of planning, design, and construction of the project without the consent, participation, and feedback of the local and regional private and public stakeholders, despite the major efforts of these stakeholders to be heard and their concerns taken into consideration; and (d) it paid no attention to the multiple intended and unintended social, economic, and environmental impacts of the project and neglected to produce a comprehensive plan for the post-construction monitoring, evaluation, and mitigation of unexpected consequences of the project itself and other external factors such as the lack of annual rainfall and climate change. As a result, this case study leads to a critique of the interface of planning, policy, and governance of water resources at the local, regional, national, and multi-national levels in Greece, and potential in other parts of the EU and beyond.

As this case study reveals, the Aposelemis Dam is a highly contested project. It might appear to be an exaggerated example of the problems in water management planning and implementation in Europe, due to the specific characteristics of the Greek policy and governance arena (which our case study and many other studies and academic papers referenced throughout this paper identify and explain). But, this exaggeration actually makes it easier to identify the problems and potential causes that are inherent in many large dam projects worldwide. Many of these problems are also echoed in the accounts of the Odelouca Dam in Portugal, a dam project with a similar timeframe that began operation in 2012 (Thiel, 2010). This was also an EU-funded water supply project for a highly touristic coastal area conflicting with agriculture. Below, we discuss the most relevant issues and expand the scope of the discussion to include EU level policy, funding, and decision-making in the water sector.

6.1. Underlying view of water in policy

Modernist development paradigms support a strong central government that harnesses resources and redirects them to large-scale modern economic development. In the case of water, this is often referred to as the hydraulic paradigm, in which water is viewed as a discrete state resource valued only for economic development or improving quality of living conditions. This viewpoint, which for years has been critiqued as not working well in today's social-economic conditions and broadening awareness of environmental sustainability questions, is dominant in Greek governance of water as well as in Portugal and other southern countries in Europe (Thiel, 2010). In the EU WFD, this viewpoint is redirected to view water as a resource that is an integral component of bioregions and watersheds as well as intricately interwoven into the socio-cultural and economic aspects of a landscape. This adds complexity to the understanding of water, and hence new complexities to planning and management. The EU rearranged its policies and governance and management guidelines to better respond to this expanded conceptualization of water. It appears that it was a shift to respond to the ideas of sustainability and integrated problem solving and to promote innovation in place appropriate long-term solutions to water provision and management. However, it is obvious that this transition has not been smooth nor complete. And it is questionable how long it will take for these narrowly defined views of the water to be replaced in decision-making of Greece and other countries. The outcomes in water management, in other words, the types of projects funded and implemented, are predicated on these underlying belief systems. Other outcomes are a mismatch to the entire apparatus in place to guide water management from the top-down.

6.2. The long timeframe of this project

This project was finally funded by the EU 30 years after it was decided as the solution to meet the water demands of the coastal cities and began partial operation 13 years after it was funded. This project took place under multiple water policy regimes in Europe and Greece and multiple local governance regimes in Greece. It also took place during major shifts in the views of the efficacy of large dams, evidenced by the widely read WCD report of 2000 and documented de-damming in USA and Europe, and shifts to alternative, more flexible water management solutions. This project was out of date before it started. And it is incomprehensible that the Greek Government over and over refused to diverge from the original proposal, despite scientific and engineering studies that pointed to its flaws and the local government and citizen opposition to the way the project was handled. And even so, the EU funded this project knowing all these issues, after it reformed its official policies on water management. This is very similar to what happened with the Odelouca Dam in southern coastal Portugal. Thiel (2010) describes a similar disconnect in Portugal between states policies, objectives, and best practices and the project that was funded by EU and implemented. He attributes some of this to secretive deals among politicians.

The tenacity by which the Greek Government was able to maintain a more than 40-year-old water management solution is indicative of a system that does not take the true meaning of planning seriously. The driving factor for most, if not, all decisions around this project was to have a large EU-funded infrastructure project. It was obviously not about the best comprehensive solution to meet the need for water (much of which is to support mass tourism). There was opposition from the decision-makers to spend time considering innovative or more place appropriate alternatives or to seriously

think of future-oriented solutions or the long-term management of the project. There is no serious disaster preparedness or environmental and landscape restoration and remediation, both concerns for years to come. The lack of foresight in considering climate variations and changes, which have been documented historically and have been predicted for the island of Crete into the future through various studies, is troubling. All of this lack of ability or interest in seriously thinking forward has crippled the success of the project before it even has fully started operation.

6.3. Greek governance and planning

The project is rife with problems that reflect the reality of politics and governance in Greece, in particular, in the area of public works. Despite several national level changes in local governance structures to decentralize decision-making and responsibility, local autonomy is still weak. In general, the system is heavily top-down, the laws, regulations, and policies are byzantine in nature and so difficult to follow and carry out. Overlap this with new and evolving EU initiatives and requirements which do not easily synchronize with the existing system results in maintaining the decision-making power in the hand of a few powerful state leaders. Responsiblities are unclear and often unmet. Objectives and philosophies of water management are not consistent at each level (local, regional, state, and EU). And the complexity of navigating and meeting all the policy and regulatory requirements creates infinitely slow processes, resulting in shortcuts that work around these requirements.

6.4. Disconnect from stakeholders/scientists/governments

In addition, serious attention to input through the participation of stakeholders, which are both private and public, is non-existent, though it is required. This situation is further exacerbated by the weak culture of civil society. The networks through which citizens and interest groups can have a voice in government decision-making are almost non-existent. As this case makes clear is not just the citizens that have no voice. Local and regional governments and government agencies, who are all supposed to be involved in such a project, were marginalized and given no credence. Additionally, the knowledge and studies by professional experts in science and engineering were not utilized. This lack of process to have local and professional knowledge seriously taken into account precludes the possibility for sustainable, equitable, and locally appropriate solutions to be implemented.

6.5. Costs

Several of the inadequacies in the planning of the project identified in the assessment had significant cost implications (63.7 million euro overrun making the cost-to-date 55% higher than estimated). There was overrun in the cost of the water pipelines, because it was realized that the proposed placement of the pipes would disrupt existing settlements. The placement of pipelines was redesigned to bypass these communities, lengthening the total pipeline. Lasithi Plateau augmentation works were also a major source of overruns for three major reasons. First, the lack of participation opportunities for local residents and governments resulted in opposition that delayed implementation of the proposed plan. Second, local residents were concerned that the plateau water would be completely drained, depleting the local aquifer and effectively destroying the local agricultural economy. Eventually, the government was forced to build two smaller irrigation reservoirs in the plateau. Third, the lack

of careful and sufficient environmental assessment surfaced as the construction of the tunnel to bring the plateau waters to the channelized river to the reservoir began. The mountainside between the plateau and the valley is designated as both a Natura2000 and a Corine biotope protected area. Consequently, the government was forced to implement a new environmental study and project design that would meet the environmental terms of these designations. This resulted in the construction of a 3.5-km underground tunnel, a much more difficult and expensive solution, which to date is still not completed.

6.6. EU participation

There are many issues related to integrating this supranational level of governance and policy to the state and then on down to their regional and local levels. This case study particularly reveals an issue in the allocation of EU funding for public works tied to economic development. There appear to be gaps in if and how this funding is tied to overarching EU directives. This is magnified due to the weak articulation of the Water Framework Directives into state and local level structure and practices in water management. Consistency and transparency would be beneficial for better outcomes. But even more so, the expectations for unified and uniform transformations of government and policy structures in countries of widely varying cultures and histories are difficult to materialize. In Greece, these expectations for a shift in water policy and management were addressed by added superficial layers of structures that end up not playing a role in projects like the Aposelemis Dam.

Our findings also indicate that flaws exist in the ways EU-funded projects are being implemented. It appears that the EU approves proposed projects submitted by country members by strictly considering the formal government proposals of the technocrats and the politicians without regard or attention paid to the rest of the stakeholders and the public at large. The oversight of funded projects appears to be hands-off once the original approvals have been completed. Thus, country members feel no obligation to follow terms and conditions considered essential for the good planning and implementation of a project. Country members, in this case Greece, are allowed to exercise top-down approaches to the inception, planning, and implementation of major public works projects based, not on good science, through investigation of needs and options, or by following the accepted guidelines for sustainable development projects, but rather on political expediencies and the priority of obtaining and spending the allotted EU funds. Comprehensive long-term planning, issues of development and project sustainability, concerns for the protection and restoration of the environment, the obligation to actively involve the affected stakeholders, and the relevant civic actors are all considered by the state to be secondary and non-mandatory terms of the project.

In the case of the Aposelemis Dam project, these failures of both the EU and the Greek central government are at the heart of the outcomes of the Aposelemis Dam project. This largest public works project on Crete to date has not been able to deliver either its water supply objectives or its local and regional development goals. As a result, the coastal area of Heraklion-Agios Nikolaos, the largest population concentration and the most important tourism region of the island, is still in need of water to meet the needs of both its population and business, and the millions of tourists visiting it annually. At the same time, both the Aposelemis River basin and the Lasithi Plateau, the two directly affected regions of the project, have been traumatized, with severely damaged natural and cultural landscapes and with no means to address the post-project neglect of the central government.

7. Conclusions

Increasingly, ideas of best practices in water management are shifting away from past century modernist-based approaches towards viewing water as part of both natural and socio-economic systems, responding to and innovating around local knowledge and conditions, and integrating objectives of sustainability that will balance the interrelationships among nature, economy, and social inclusion. Climate change is increasingly becoming a necessary consideration in long-term planning, especially in the area of water resource management. The study of the Aposelemis Dam reveals that these current directions of water planning and management did not happen in this case. And accounts of other projects in Greece and other countries in Europe confirm that many elements of concern from our case study are happening in other places as well. So the question becomes how to bridge this gap in practice.

Based on this case study, questions emerge that merit further research. As the Aposelemis Dam is not yet totally operational, it will be interesting to continue to follow the progress of implementation and operation to further document the failures and successes of this project. Regarding the EU, an investigation of water project funding and implementation after 2012 (the date when countries were to integrate the WFD into water management) to evaluate the impact of the policy change could be informative in better identifying weakness and best practices to better inform water management funding. Both this study of the Aposelemis Dam and that of the Odulouca Dam (Thiel, 2010) imply that the countries of Europe with drier climates and high levels of coastal tourism are often forced to deal with pressures to divert water from other uses to tourism water demands. These types of regions may need a more situation appropriate set of water planning and management practices. The further study of the on-the-ground issues in such regions in Europe and beyond could inform more place-specific guidance in process, planning, and solutions.

The EU has developed new policies and directives that guide a shift away from the tendency to revert to the hydraulic paradigm. However, the transformation to improved structures and practices to meet them has been slow and may never materialize in all countries. Changing the underlying beliefs and philosophies of water as a life-giving resource and its connection to socio-economic development is key. Decision-making ultimately responds to the conceptualization and value given to water. To move beyond the outdated viewpoint, massive and consistent education and awareness building is needed within the public sector as well as more widespread through society. Another shift that could improve water planning and management in practice is to move away from a technocratic approach that values tried and true technical solutions in order to move through a bureaucracy and accomplish projects. This technocratic approach inhibits innovations and devalues inputs and knowledge from a wide range of contributors. As the complexity of water as both a natural resource and as a socio-economic resource is better understood and reflected in policy, more diversity of inputs into problem solving and implementation will be needed. We are living in a time of rapid change. These changes are increasing in our natural systems, as evidenced through climate change, as well as in our socio-economic and political systems. Large, inflexible investments and projects become achronistic monoliths very quickly in such a world. Smaller, locally appropriate, flexible solutions may become better investments. Policy making, decision-making processes and planning processes that are more nimble, less resistant to change, and more place-appropriate are needed to usher in this next generation of water resource planning and management.

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