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Abstract: The effect of uncertainty on cooperation between the partners sharing the natural resources remains unknown. Uncertainty may strengthen cooperation between partners, as it is necessary to implement cooperative mitigation policies, however, it may also serve as a cause of friction between parties, as it may aggravate existing trust issues or power asymmetries. Given the potential for such contrary outcomes, we examine empirically how uncertainties in a transboundary setting seem to promote or impede cooperation. Taking Israeli-Palestinian Annapolis round and post-Annapolis negotiations as a case study, this work identifies the effect of uncertainties related to water on negotiation positions. Our results indicate that social and political uncertainties play a much stronger role in water negotiations than do technical or physical uncertainties that often dominate in other resource issues. Uncertainties often situated outside the realm of water management tend to detrimentally affect the chances to resolve water issues. Many of the indicators used to assess the effect of uncertainty indicate that partners attempted to address uncertainties in a cooperative manner, accepting negotiation venues and rules. However, negotiating water together with other issues increased the likelihood that both the uncertainties, and the mechanisms proposed to address them, may become a focal point for friction. The fact that many of these mechanisms proposed to address the uncertainties were procedural, rather than clear and defined rules or outcomes, intensified risks, as such an open-ended approaches themselves create their own uncertainties. The potential effect of the mechanisms proposed to address uncertainty on conflict and cooperation varied both across mechanism types and according the indicator used to evaluate them.

Editorial Board
Geoforum

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Dear Editors,

We are happy to submit our article: *The impact of uncertainties on cooperation and conflict in transboundary water: the case of Israeli-Palestinian negotiations* for consideration for publication in *Geoforum*.

The article is currently 8.242 words.

We look forward to hearing your response.

Sincerely,

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The impact of uncertainties on cooperation and conflict in transboundary water: the case of Israeli-Palestinian negotiations

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1. INTRODUCTION

Water management inherently entails addressing uncertainty, given the stochastic nature of both supply and demand. Uncertainties affect both physical dimensions of water supply, such as precipitation patterns, as well as social aspects, including investment and technological development. A host of uncertainties also affect water demand, including economic development, changes in preferences, and cross-elasticities for other goods. Climate change adds uncertainties to water forecasting as it affects a wide range of both supply and demand side aspects of water management, as well as the provision of ecosystem services (Raadgever 2005; Miller 2008; Cooley et al 2009). Uncertainties regarding policy responses to climate change are greater still than the uncertainties regarding the physical aspects of such change (Raadgever 2005). Such uncertainties can be aggravated by the interactive effects and feedback loops in both the physical processes and the institutional responses (Young 2010). Such physical and policy uncertainties have inspired a long literature calling for innovative and adaptive approaches to water management (e.g., Gleick 1989; Boland 1998; Raadgever, 2005; Milly et al 2008; UNECE 2009).

The variety of uncertainties and the challenge these pose is compounded in a transboundary setting. Policymakers in a transboundary setting deal with uncertainty regarding the preferences and behavior of riparian states and negotiating partners, which are exacerbated under conditions of conflict and mistrust between parties (Raadgever, 2005; Miller 2008; UNECE 2009). As in other cases of international governance, relative to national or sub-national level management, transboundary water management is characterized by a lack of centralized decisionmaking, an increase in the number of both stakeholders and negotiating partners, increased possibilities for issue spillover, and the possibility of gamesmanship among parties. In light of such uncertainties, many have called for increased international cooperation and reliance on transboundary water agreements (e.g., UN 2009). Others have claimed that uncertainties, especially those due to climate change, may pose challenges to existing agreements other international water law, and entail their amending (e.g., Goldman 1990; Dellapena 1999).

Many studies assume that uncertainties have negative effects on water management (e.g., UNECE 2009), and examine how transboundary water agreements attempt to address these uncertainties (e.g., Goldman, 1990; Fischhendler, 2004; Drieschova et al, 2008, 2011). There are few studies, however, that have examined how the different uncertainties and the mechanisms prescribed to address them effect the propensity for promoting conflict or cooperation among riparians. Furthermore, relatively little literature has focused on how the interaction between uncertainties impacts countries' ability to develop and implement cooperative water governance. This study seeks to address these gaps in the empirical literature. Taking the Israeli-Palestinian water agreements and subsequent negotiations as a case study, this work investigates the effect of different types of uncertainties on the likelihood of implementing cooperative or non-cooperative water regimes for shared water resources.

The study proceeds as follows: The following section provides a review of the literature on the types of uncertainty and their hypothesized effects on cooperation and conflict over environmental and resource management, and briefly outlines various mechanisms that have been used to address uncertainties in this context. Section three presents a description of the

methodology of the current study. Section four presents a brief overview of the water resources of the case study area and explains how uncertainties were addressed in the Israel-PLO interim peace agreement. Section five presents the results of an analysis of negotiation protocols. Section six provides a discussion of these results, and section seven offers conclusions and suggestions for further research.

2. LITERATURE REVIEW

2.1. Types of Uncertainties and Natural Resource Management

There are numerous types of uncertainties affecting water resource management and several alternative ways to categorize them. Many studies, for instance, distinguish between inherent variability in a stochastic system (e.g., annual precipitation) and incomplete knowledge of the system (e.g., the environmental impacts of a certain water supply technology) (e.g., Iida 1993). Incorporating policy issues, Brugnach et al (2008) added “ambiguity,” i.e., uncertainty resulting from the possibility of different interpretations of events, rules, agreements, risks, study results, etc. Such observations are supported by observations such as Helm’s (1998) “that decision makers in different countries are likely to attach different subjective probabilities to the occurrence of damage scenarios, even if they possess exactly the same information” (p.198). This is especially relevant for highly technical or complex issues such as climate change, for which decisionmakers are dependent on numerous experts in a range of fields for information and assessment of risks, and when management involves highly conflictive parties.

In order to effectively identify appropriate areas for policy intervention and assess the appropriateness of policy recommendations, one must also be specific about what the object of uncertainty is and what type of knowledge is at stake. Brugnach et al (2008) specify three objects of uncertainty: the physical system, social system, and technical system. The physical system comprises issues like precipitation, water quality, etc.; the social system issues such as policy, demographics, institutions; and the technical system technology-related interventions to address water management, e.g., dams, irrigation equipment, wastewater treatment. .

Understanding the types and object of uncertainties is potentially important in order to evaluate best policy responses, both to reduce the uncertainties themselves (e.g., mitigation) and to help focus on alternative policies which are less certain but will assist in the event of detrimental outcomes of uncertainty (e.g., adaptation) (Boland 1998; Pahl-Wostl 2007). Langsdale (2008) noted that if uncertainties inherent in the system dominate, “the focus should shift away from reducing uncertainties and move on to clarifying and communicating what *is* known about the system and determining effective and robust responses.” Ambiguity is particularly important when discussing transboundary water management, given the potential for differences between countries in terms of perspectives, narratives, and relative importance placed on various decisionmaking criteria (Fischhendler, 2008a).

2.2. The Effect of Uncertainties on Cooperation or Conflict

Both the theory and empirical evidence regarding the role of uncertainty in achieving cooperative regimes are mixed. Young (1994) claimed that uncertainty can serve to facilitate agreement on the core of international environmental agreements since uncertainty about the

distribution of costs and benefits (both one's own and those of one's negotiating partners) is likely to lead to cooperation over rules that are deemed fair. In line with such a claim, Ulf and Maddison (1997) developed a game-theoretic model and found that information may actually have a negative impact, as it can lead to non-cooperative equilibria with lower levels of aggregate utility. Helm (1998) also developed a game-theoretic model that confirmed Young's claims, finding that uncertainty produced a cooperative equilibrium. Ro'tulo Decuadra and Oliveira (2008), in studying the effectiveness of international environmental agreements between Brazil and Uruguay, went one step further and argued that scientific uncertainty can not only foster cooperation, but can also enhance treaty effectiveness. In their case both parties needed to implement the agreement in order to reduce scientific uncertainty. Thus, both theory and empiric studies suggest that uncertainty may actually facilitate cooperation.

However, several researchers have reached opposite conclusions, i.e., that uncertainty deters cooperation over natural resources (see for example, Koremenos et al, 2001). In an assessment of public health agreements, Cooper (1989) concluded that "so long as costs are positive and benefits uncertain, countries are unlikely to cooperate systematically" (p.181). Hine and Gifford (1996) demonstrated that greater environmental uncertainty can lead to increased individual tendencies to pursue private interests rather than to act for the collective good, producing results that were suboptimal from both an economic as well as environmental perspective. Such findings are in line with tragedy of the commons type theories that predict that uncertainty about other actors' actions is likely to lead to non-cooperative behavior that fails to produce sustainable outcomes in common pool resource management (Hardin 1968; Ostrom et al 1994). Even Helm, in the same article cited in the previous paragraph, found that model (or scientific) "uncertainty can be detrimental to the process of international environmental cooperation as well, because it enables countries to defect from cooperation on grounds of 'not proven'" (p.198). There is much empirical evidence to corroborate such claims, from global talks on acid rain, ozone layer depletion, and climate change (e.g., Gehring 1994, Benedick 1998).

In the realm of transboundary water, some scholars have found correlations between changes in rainfall or high levels of variability in rainfall and the likelihood of violent conflict (Miguel et al. 2004; Levy et al. 2005; and Hendrix and Glaser 2007). The pathways to such conflict are varied, including direct pathways such as fighting over access to scarce resources or indirect ones such as violence stemming from political instability due to migrations resulting from resource scarcity. In a similar vein, Fischhendler et al (2011) found that mistrust (uncertainty about riparians' future actions), can alter the benefit-cost ratio in favor of unilateral action over cooperation, especially in cases of tense and/or conflictual political relations between riparians. In contrast, Fischhendler (2008a) found that certain types of uncertainty can play a positive role in achieving such cooperative regimes. In line with Young's (1994) argument above, he found that ambiguity (i.e., uncertainty regarding interpretation of agreement specifications) was essential in getting parties involved in a conflict to overcome distrust and reach agreements on water sharing; yet, this uncertainty can become destructive during the implementation phase of the regime (Fischhendler (2008b).

2.3 Mechanisms for Addressing Uncertainties

Given the potential for conflict over shared water resources, especially considering the anticipated role of climate change in aggravating regional and temporal uncertainty, many sources have advocated cooperative management regimes (e.g., UNDP 2006, UNECE 2009). International agreements are an oft-promoted method for promoting such cooperative relations over transboundary waters. They are designed to reduce political and physical uncertainties by establishing working rules of engagement and establishing protocols for interaction between parties. Over 400 such transboundary agreements have been signed in the last 200 years (TFDD 2011). In their survey of 289 agreements signed since 1900, Drieschova et al (2011) found that nearly two-thirds explicitly mention uncertainties (although just two specifically mentioned climate change related uncertainty), with the majority including multiple mechanisms for addressing them.

However, transboundary agreements, while cooperative acts designed to reduce certain uncertainties, do not guarantee actual cooperation among parties (Kliot et al 2001). Furthermore, they can create new uncertainties, especially in terms of interpretation by parties (Drieschova et al (2011). In particular Miller (2008) noted that because "in many cases allocation rules and enforcement mechanisms are not clearly defined... [uncertainty due to] climate change could destabilize such agreements if it... causes a sharp drop in one or another country's perceived payoffs from continued cooperation" (p. 43). This has resulted in calls for adaptive management mechanisms to be incorporated into water management, especially transboundary water management (Scholz and Stiftel 2005, UNECE 2009, Gupta et al 2010).

The need for adaptive governance to address uncertainty triggered the work of Drieschova et al (2008) that investigated the different governance mechanisms employed in international water agreements to address flow variability, such as flexible allocation mechanisms, and found that most deviate from the ideal and reflect trade-offs between flexibility and ability for enforcement. In a follow-up study, the same group of researchers found that the capacity of agreements to address uncertainty has developed over time (Drieschova et al 2011), including procedural, financial, infrastructure-related, information-related, and resource-related instruments. Tir and Stinnett (2012) in an empirical analysis of transboundary conflicts, found that water treaties that contain more institutional features/mechanisms, such as joint management, can be expected to better manage conflicts caused by water stress arising and uncertainty, for instance, from climatic uncertainty.

Data and information exchange are commonly used mechanisms increasingly included in transboundary water agreements in order to reduce uncertainty. However, Gerlak et al (2011), in a review of use of data exchange in international treaties, noted that their effect on cooperation was ambiguous. They also concluded that "the increased propensity for direct data and information exchange in multilateral basins goes hand in hand with greater ambiguity, manifested by the higher proportion of unclear exchanges. The ambiguity they uncover is consistent with earlier research on international waters which suggests that states may intentionally design vague mechanisms in order to allow for greater flexibility in the face of resource uncertainty" (Fischhendler, 2008a).

In sum, while it is clear that both physical and political uncertainties can affect the ability to promote collective action or aggravate conflict over shared water resources, the question of the relative importance of such uncertainties (and mechanisms to address them) on cooperation remains unanswered. This study is an attempt to begin to address this gap in the literature.

Table 1 below presents a categorization of the three types of uncertainty mentioned in the previous section: inherent in the system, incomplete knowledge, and matters of interpretation, and presents examples of each for the physical, social, and technical/technological systems. It then provides examples of types of mechanisms that have been included in transboundary water agreements in order to address such uncertainties. It is important to keep in mind that there are clearly interactions and feedbacks among the types of uncertainties. For instance, uncertainty about changes in precipitation will impact future resource prices which will impact the choice of technologies researched, which in turn may impact the extent of climate change, including the changes in precipitation.

Table 1 here.

3. METHODOLOGY

3.1 Data Sources

In order to answer these questions, we analyzed the negotiation process between the Palestinian Authority (PA) and Israel that took place just prior to and during the “Annapolis Conference,” and subsequent “post-Annapolis” negotiations, spanning the time period 2007 through 2009. We utilized detailed documentation of negotiations leaked to the Al-Jazeera news network and disclosed under the title “The Palestine Papers.” Taking the database of over 1600 documents relating to Israeli-Palestinian negotiations, we conducted a word search for “water”, which identified over 200 documents. Of these, 47 were protocols of official negotiation meetings that dealt in some substantive way with water issues. These included 29 bilateral Israeli-Palestinian meetings, 5 trilateral meetings between Israeli, Palestinian, and U.S. delegates, and 13 bilateral meetings between Palestinian and U.S. negotiators, with no Israelis present. These ranged from the highest level negotiations, involving the senior negotiators for each party, to technical meetings on water and infrastructure. The majority of negotiations were not centered around water; rather, water was one of several issues discussed. The Palestine Papers, while not representing official policy or even a systematic review of Palestinian and Israeli water concerns, do provide a glimpse into the types of issues of interest to political officials and how they are addressed in actual high-level negotiations.

3.2. Indicators and Evaluation Criteria

We identified the meetings in which issues of uncertainty were raised, the number of uncertainties raised, and which party raised them. We then categorized the types of uncertainties according to the typology presented in Table 1, i.e., physical, social, and technical, and whether they were inherent, due to incomplete knowledge, or are matters of interpretation. We also identified the types of mechanisms prescribed by the parties to address the uncertainties. In an attempt to group them by category, we differentiated between those that relate to negotiations (e.g., deference to outcomes of non-water related

negotiations), those based on legal instruments (e.g., adopting international law), those oriented around infrastructure (e.g., building a desalinization plant); and those that called for data and information exchange or for further study (e.g., feasibility studies).

Several indicators were used to assess whether identified uncertainties promote or impede cooperation between parties. These indicators included:

- a) Which type of uncertainties were raised and whether they, and the mechanisms prescribed to address them, create spillover effects that impact topics beyond water
- b) Whether negotiators deflected decisions to other venues that are allegedly better fit to address the uncertainties;
- c) Whether implementing the mechanisms to address the uncertainties demanded consensus or can be carried out unilaterally
- d) Whether the mechanisms suggested to address uncertainties were accepted by the parties or disputed
- e) Whether the mechanisms affect existing power asymmetries between the two sides

Regarding the first indicator above, the underlying assumption is that uncertainties and mechanisms that spillover into other issues may create further conflicts in the future and thus new uncertainties and are expected to delay the negotiations. This is why the mechanisms suggested by the parties were also categorized by their strategy based on whether they were open-ended¹, complete contract², or just an attempt to reduce uncertainty³. The open-ended ones are assumed to have the potential to create more uncertainties and spill to other issues as they set up a venue to clarify the regime rather than clear-cut rules as in the case of complete contract (Drieschova et al 2011). With the second indicator the underlying assumption is that deflecting decisions to other venues and deliberately making connections between and within components of regimes is counter productive for the regime (Axelrod, 2012). Regarding the last indicator, the assumption is that mechanisms that alter the power balance are likely to meet more resistance and thus, postpone the negotiations, rather than promote them.

4. ISRAELI-PALESTINIAN WATER NEGOTIATIONS

4.1 The physical setting

Both Israel and the Palestinian Authority (PA) suffer from chronic water scarcity, as defined by the commonly used Falkenmark (1989) measure of 500m³ per capita annually. Israel's per capita renewable freshwater resources are estimated at roughly 200m³, while the PA's are

¹. The premise behind open-ended strategy is that uncertainty is inevitable. The solution, then, is to leave room for change by including flexibility and adaptability in the design of management systems. Such mechanisms include establishment of dispute resolution mechanisms or mediation, for instance.

² Complete contracts strategy focuses on reducing the implications of uncertainty. Under such an approach, agreements specify each party's obligations under all potential scenarios that may arise out of uncertainty, leaving no space for ambiguity in treaty interpretation or performance. Such mechanisms include establishment of fixed water allocations or payment schedules or building of infrastructure, for instance.

³ An uncertainty minimization strategy is a mechanism according to which agreements attempt to reduce either the implications of uncertainty or its core causes. The assumption behind this strategy is that uncertainty reduction can produce social benefits. Such mechanisms include data exchange or establishment of monitoring systems, for instance.

less than half of this amount (IWA 2009; PA 2011). The primary water sources in the region are the Jordan River system, the Coastal Aquifer, and the Mountain Aquifer, all of which are shared. The Jordan River system is also shared with Jordan, Lebanon, and Syria. Of these, the Mountain Aquifer is the most important shared resource between Israelis and Palestinians. Most of the recharge area of the Mountain Aquifer lies in the West Bank, while most of the springs from which it naturally discharges lie within Israel. The Mountain Aquifer represents nearly all of Palestinian water supply in the West Bank, and slightly more than one-third of Israel's natural water supply. The West Bank is a riparian to the Lower Jordan, which because of upstream diversions by all other riparians, is currently denuded and of unusable quality. As such, while the Palestinian Authority maintains rights to Jordan River water, in practice it does not utilize its waters. The water supply of the Gaza Strip is almost entirely from groundwater sources, which are adjacent to, but largely separate from the bulk of the Coastal Aquifer in Israel.

In addition to natural sources of freshwater, Israel treats and reuses nearly 70% of wastewater, adding an additional 25-30% to its water balance. This percentage is expected to increase to nearly 100% in the near future (IWA 2011). In addition, over the past decade, Israel initiated large scale desalination projects which currently add an additional 20% to the water balance, and it has plans to add an additional 20-40% of capacity by 2020 (Dreizen et al 2008), at which time non-natural sources of water will equal or even surpass freshwater sources. The Palestinians do not have any desalination capacity, nor do they make significant use of treated wastewater. Both parties are withdrawing water at beyond renewable rates.

4.2 The political setting

Water was addressed specifically both in the multilateral peace negotiations beginning in Madrid in 1991, in which water designated one of five tracts for special attention, and in the bilateral Israeli-Palestinian "Oslo Negotiations", which led to the interim agreement signed between Israel and the PLO in 1995. The interim agreement established several cooperative mechanisms that have been cited as important for reducing uncertainty and creating a resilient agreement, including establishment of joint management institutions, joint monitoring and enforcement, data exchange, and joint development of water and wastewater infrastructure (e.g. Feitelson and Haddad 1999). The agreement also commits both sides to take unilateral steps, including pollution prevention and protection of water sources. The agreement calls for fixed allocations to the PA, rather than the flexible allocations cited by many scholars as important for adaptive management. However, in the agreement both sides do recognize the need for "adjusting the utilization of the resources according to variable climatological and hydrological conditions" (Annex III, Article 40.3.d).

The agreement was intended to be an interim agreement to be replaced within five years by a permanent status agreement. As such an agreement has yet to be negotiated; the interim agreement has become the de facto management regime. Several observers have lauded the agreement and the institutions it created for promoting cooperative management, noting that the Joint Water Committee (JWC) set up under the agreement continued to meet and function even when all other joint institutions ceased during the Palestinian uprising. However, others have claimed that the JWC and other joint institutions are not cooperative, but rather a means of extending Israeli hegemony (e.g. Selby 2003; Zeitoun 2007).

This situation prompted Israel and, to a lesser extent, the PA to attempt to implement unilateral policies when political costs of cooperation have been high (Fischhendler et al 2011). In response to drought, climate uncertainty, and growing water demand, Israel has pursued a unilateral policy of large scale desalination. This adaptive strategy has reduced uncertainty related to future precipitation, by increasing overall supplies; however, it has raised new political uncertainties, as the PA now claims that Israel is now less dependent on shared resources and thus, should be more flexible in water negotiations (Atilli 2011).

The closest the parties have come to a permanent status agreement is the negotiations leading up and immediately following to the U.S. led Annapolis Conference of 2007. This Conference represented the first time that a two-state arrangement was presented as a mutually agreed upon permanent status resolution to the Israeli-Palestinian conflict. The conference produced a joint statement by the Israeli, Palestinian,⁴ and U.S. governments announcing the agreed upon two-state arrangement and the commitment of all sides to work in subsequent negotiations towards resolving the details of such an arrangement.

In the following section, we analyze protocols of negotiations aimed at producing a final status agreement in an attempt to understand how the social, physical, and technical uncertainties were addressed by both the high-level politicians and technical specialists.

5. RESULTS FROM ANALYSIS OF UNCERTAINTY IN WATER NEGOTIATIONS

Taking the Palestine Papers database, 47 meetings dealt with water in a substantial manner. Of the 47 meetings analyzed, 47 different uncertainties were raised in 28 different meetings, while 19 meetings raised no issues related to uncertainties. Of the 47 different types of uncertainties, 23 (49%) were raised by Palestinians, 17 (36%) by Israelis, 4 (9%) by the U.S., and 3 (6%) by both Palestinians and Israelis⁵ (see Table 2). Of these, 34 (72%) were raised in meetings of politicians, while 13 (28%) were raised in meetings of technical experts.

In terms of the object of uncertainties raised, 34, or over two-thirds, were social in nature (almost exclusively political), 9 were technical, and only 7 were physical, i.e., relating to some aspect of climate or hydrology.⁶ Both Palestinians and Israelis focused primarily on social (political) uncertainties, as seen in Table 2. In the Palestinian case, social issues dominated overwhelmingly, representing 20 of 23 different uncertainties raised (87%). In terms of types of uncertainties, over half (27) were related to interpretation, while most of the rest (19) were due to incomplete knowledge, with relatively few (5) relating to inherent uncertainties such as resource stochasticity (see Table 1). Both Palestinians and Israelis raised uncertainties primarily related to interpretation. However, both sides also raised a number of issues related to incomplete knowledge. Inherent uncertainties, which tended to be related to physical and technical issues, were hardly raised. Palestinians raised none at all.

⁴ The Palestinian government at the time was contested and divided, with the President and his Fatah party governing the West Bank and the Prime Minister and his Hamas party governing the Gaza Strip. The President and his representatives were those taking part in negotiations with the Israelis, and it is to them that we refer in this study when referring to “the Palestinian Authority” or “Palestinian representatives”.

⁵ Some uncertainties were raised by both Israeli and Palestinian representatives in negotiations, and so were treated as a separated category, rather than attributing them to one or the other.

⁶ These sum to 50 rather than 47, as 3 uncertainties were categorized as both physical and technical.

Table 2 here

Figure 1 presents the mechanisms strategy suggested by Israel, the Palestinians and the US which often served as a mediator. In terms of mechanism strategies recommended for dealing with uncertainties, Israelis and Palestinians both proposed open-ended type mechanisms 42% of the time (Figure 1). Such open-ended mechanisms afford the most flexibility and adaptability, however, they are often procedural, and as such, may themselves open up new uncertainties. The Palestinians proposed complete contract type mechanisms 37% of the time, in contrast to Israel, which did so only 17% of the time. Complete contracts offer greater certainty about specific parameters and a higher chance that parties will comply with the agreement, but often at the expense of flexibility. For Palestinians, certainty seems to have been more salient or urgent than flexibility.

Half of the mechanisms called for resolution through further negotiation channels or deferral to technical or specialist committees. The other half of the mechanisms was distributed almost equally between legal tools, infrastructure, and information collection and exchange and research studies (Figure 2). Among the legal tools were increased domestic law enforcement measures as well as application of international law, for instance, in the case of Palestinian claims to a share of the Jordan River. Infrastructure included projects for new water, such as desalination and construction of a canal, connecting the Red and Dead Seas, as well as for allocation of existing water, for instance, a Palestinian proposal for pipelines to deliver water from the Jordan River system to the West Bank. Information collection and calls for research included technical feasibility studies as well as submission of position papers on issues that would affect water rights.

Figures 1 and 2 here.

The mechanism types were analyzed according to five indicators in order to assess their effect on cooperation (Table 3). For each type of mechanism we evaluated the percentage that met the criteria for each of the indicators. For example, 50% of mechanisms suggesting future negotiations or committee work had power implications while only 20% of the mechanisms calling for data exchange or joint research studies did. For most of the mechanism types, the majority of mechanisms proposed had power implications, with one the exception being those dealing with data exchange and feasibility studies, for which only 20% had power implications. Spillover effects of the mechanisms that deal with further negotiations and building new infrastructure also seem to be higher than those that deal with legal instruments and data exchange. The spillover effects overwhelmingly tended to be related to negotiations over borders or related to matters of national sovereignty. Only an isolated number had spillover effects on other issues such as refugees or finances. Interestingly, the direction of the spillovers was predominantly on water issues rather than stemming from water issues onto other negotiating issues. Of the uncertainties and mechanisms that had power implications only 37% were likely to have some sort of spillover effect. In most cases the mechanisms suggested did not provoke a request to change the forum of negotiations to other venues. Yet, many of the mechanisms suggested were disputed between the parties. Again, the only exception is data exchange and feasibility studies that

were mostly accepted as a tool to clarify uncertainty. None of the mechanisms that were accepted by the parties dealt with uncertainties affecting power relations. While the majority of mechanisms that are based on data exchange and building new infrastructure requires cooperation, some of those that are based on legal instruments can be carried unilaterally.

Table 3 here.

6. DISCUSSION

Israeli-Palestinian water negotiations are typified by uncertainties that stem not from inherent stochasticity involved in water management, or from new uncertainties due to climate change, though both sides consider them significant (UNDP 2010; Feitelson et al 2012). Rather, they are dominated by social uncertainties around political issues that may develop new demands or restrict ability to supply, such as sovereignty over land, settlement of borders, and return of Palestinians living abroad. The social uncertainties are often around what should be negotiated and by whom, while the technical or physical ones are over information or over possibilities for new infrastructure. That social uncertainties dominate the discourse, rather than technical or physical uncertainties, such as those raised by climate change, can be understood in light of the nature of the negotiations, that were led by high level politicians on both sides rather than by water professionals or technocrats.

The types of uncertainties raised and the frequency they were raised were functions of the professional position of the negotiators, their national affiliation, and the forum in which the negotiations took place. In terms of incorporating information into negotiations, for instance, technocrats and negotiations at forums at the technical/expert level were more likely to raise uncertainties that require new data or feasibility studies, while politicians and higher level negotiations tended more to raise the issues regarding interpretation of existing data or agreements. Palestinians tended almost exclusively to focus on social/political uncertainties, almost ignoring technical and physical ones. Israelis also primarily raised social/political uncertainties, but also raised technical and physical ones that were more inherent to water general management. This is consistent with previous negotiating positions in which Palestinians tended to focus on redistribution of existing water resources, while Israelis focused on generation of additional water resources in order to overcome regional scarcity.

The type of uncertainties also influence the mechanisms suggested to address them. Physical uncertainties raise more mechanisms designed to reduce uncertainty, such as requiring data and information exchange, while social uncertainties raise more soft, open-ended mechanisms, such as dispute resolution mechanisms or further negotiations. The Palestinians tended to call for incorporation of international law, while Israelis relied more on deferring the negotiations to alternative forms and to reducing uncertainty via new infrastructure or feasibility studies for such infrastructure. This difference between the sides can be understood in light of the asymmetry in development between the two sides: water supply infrastructure is already well developed in Israel, and Israelis' dependence on shared resources is less than that of the Palestinians. Hence their concern is more reducing impact through feasibility studies and data exchange, as opposed to the Palestinians, whose primary concern is attaining additional water rights, and thus, was concerned more with strengthening its legal position and reducing the economic and power gap between the two parties.

In terms of spurring or spurning cooperation, many of the mechanisms suggested to address uncertainty were cooperative (e.g., data exchange, direct negotiations, and feasibility studies), although some forms of what is ostensibly cooperation, e.g., feasibility studies or establishment of expert committees, may, in fact, be in order to delay negotiations. In most cases the partners tried to address the uncertainty through the existing channels of communications, rather than shifting the debate to alternative forms, the true aim of which may be in order to delay negotiations. Even in those cases where an alternative form for negotiations was requested, it was often a request to move the debate to an expert committee such as those dealing with borders, rather than postponing it indefinitely or to final status negotiations.

Yet, while seemingly reducing physical uncertainty, mechanisms such as construction of new infrastructure, such as desalination, also raise new social and political uncertainties that can affect parties' willingness to cooperate (Katz and Fischhendler 2011; Feitelson and Rosenthal 2012). By engaging in massive desalination, for instance, Israel is less dependent on water resources, and thus, may be more willing to share natural shared water sources, however, it is also less dependent on cooperation with Palestinians in order to address regional scarcity. This was true too of ostensibly cooperative mechanisms put forward, such as joint infrastructure or enforcement, which immediately raised political uncertainties that impeded their adoption.

The effect of the mechanisms on the power balance is also seen in the suggested appeal of the Palestinians to international law, which they saw as potentially shifting the balance of power somewhat in their favor, while Israelis see this as a constraint, not only, or even primarily, on water policy, but potentially as a precedent that may affect potential bargaining power on broader issues such as borders and refugees. The effect of mechanisms on the power balance explains the difference in reactions to mechanisms proposed. Mechanisms that seemed to raise power implications, such as use of international law or development of joint infrastructure, tended to be disputed by at least one party, as opposed to more open-ended mechanisms, such as data and information exchange, that seemed less of a threat to power balances and hence were often accepted by both the parties.

Another indicator that seems to point to the detrimental effect of uncertainties is the frequent spillover effect between water uncertainties and other uncertainties. The spillover effect was already found to be able to paralyze negotiations over water (Fischhendler, 2008b). The frequent spillover effects between water related uncertainties and other sources of uncertainty is also a function of who negotiates and the negotiation forum. Not surprisingly, spillovers were more common in negotiations among high level politicians than in those among water specialists.

Given the prominence of open-ended type mechanisms put forth by both Israelis and Palestinians, rather than clear and defined rules or outcomes, future policymakers and/or practitioners would likely have to confront more uncertainties. For instance, even the call by the Palestinians for increased reliance on international law as a reference may not provide clear cut guidance, as international law provides many criteria for dividing the resource without prioritizing their importance or uses (Wolf 1999).

The potential effect of the mechanisms proposed to address uncertainty on conflict and cooperation varied both across mechanism types and according to the indicator used to evaluate them. For instance, legal mechanisms seemed to have a relatively high potential for raising

objections based on most of the indicators used in this study, while mechanisms such as data and information exchange and further study had little spillover effects or power implications, and tended to be cooperative and to be accepted by both parties. The importance of the choice of indicator is clear, for instance, when examining mechanisms such as building new infrastructure, which had a relatively high share of power implications and spillover effects, and were not immediately accepted by the parties, however, the types of projects proposed tended to be cooperative and parties did not try to deflect the discussions around it to alternative forums.

7. CONCLUSIONS

Uncertainty arises when actors cannot anticipate the outcome that will result from inherent stochasticity in a system, or from a future course of action or agreement. The aim of this paper is to examine the effect of these unknowns in terms of whether they trigger conflictive or collective action. To address this question we examined the Israeli-Palestinian context of acute conflict, where general sovereignty issues are a major barrier for water negotiations, and where attempts to address shared water may aggravate the existing asymmetric power balance. The result of these constraints was that negotiations over water were dominated by political uncertainties, rather than by those directly related to water.

Often the multiple uncertainties faced by the negotiators were discussed cooperatively in order to mitigate their implications, as suggested by the literature that suggested that uncertainties trigger problem solving via collective action. At the same time, many of the indicators we used to assess the effect of uncertainties on cooperation indicate that, by no means, did uncertainties allow the negotiators to overlook or go beyond political constraints. All attempts to address uncertainties had to grapple with the political concerns and with power implications. Uncertainties related to water, and mechanisms suggested to address them, were often tangled with uncertainties related to other issues, which can explain why many of the mechanisms suggested were open-ended, rather than solutions that may constrain state sovereignty. This implies that many of the challenges uncertainties pose will be addressed only during the implementation phase of a regime.

Given the fact that the detrimental effect of the uncertainties on cooperation is a function of who leads the negotiations and the mechanisms suggested to address these uncertainties, restructuring the negotiations differently may have mitigated these risks to some degree. Giving more space and mandate in future negotiations to the expert committees could have strengthened the positive effect of the epistemic communities on negotiations as their collective and scientific beliefs were already noted to overcome gridlock in environmental treaty negotiations (Haas, 1990; 1992). However, amplifying the voice of the technical level is not a straightforward option, given the ramifications of water on the other channels of negotiations. One solution to this dilemma could be if the water channel would be the first or the last issue discussed after the other channels were agreed upon. Basic parameters could be presented upfront, while technical details, which are more easily dealt with by professionals, rather than by politicians, left to the end. This would potentially avoid the gridlock caused by intentional policy linkage encountered when negotiating issues concomitantly. Such a strategy could be suitable given the direction of spillover effects found, in political issues tended to impact water policy much more than vice-versa. In this case, such a policy would

have prevented the domination of political uncertainties over inherent water uncertainties. The precise implications of such an institutional restructuring, however, require further study.

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*Highlights

- Current theory and limited empirical evidence on the effect of uncertainty on cooperation and conflict over transboundary resources is contradictory
- This case study demonstrates that the conclusions are dependent on choice of indicator
- In terms of mechanisms chosen to address uncertainty, open-ended ones that do not upset existing power-balances are more likely to be accepted by consensus and promoted cooperatively, but these are likely to address short-term uncertainties, while creating new long term ones.

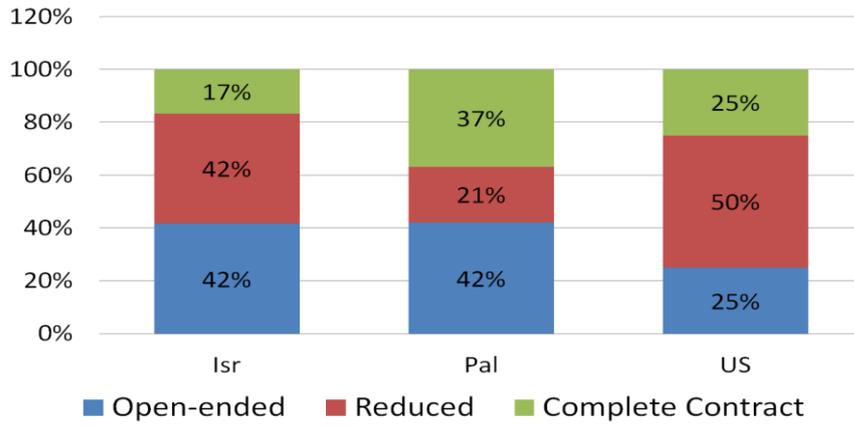


Figure 1 – Mechanism strategy by party

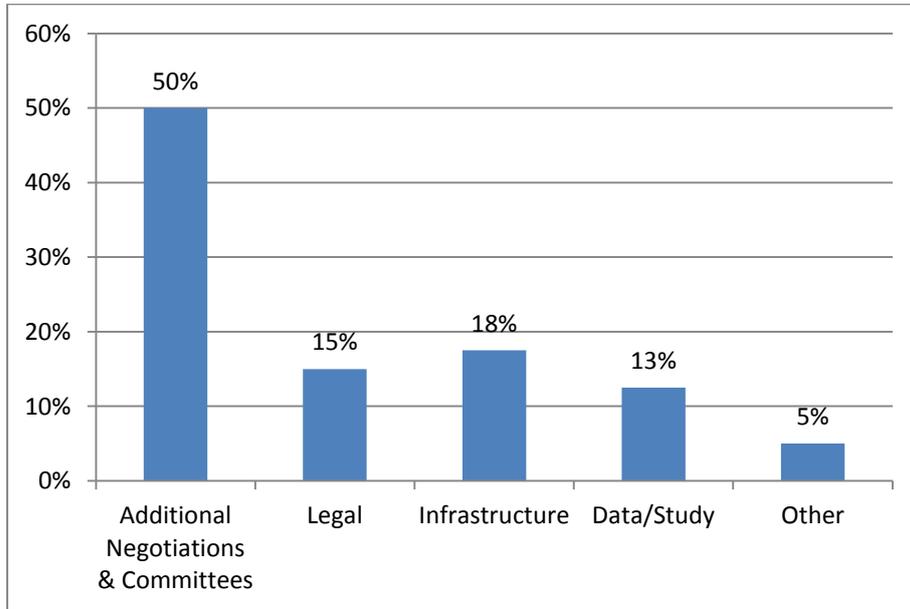


Figure 2 – Mechanism types proposed

Table 1. Types of uncertainty in the context of transboundary water under conditions of climate change and examples of mechanisms to address them

Object	Type	Examples	Mechanisms
Physical	Inherent	<ul style="list-style-type: none"> • Temperature fluctuations • Precipitation variability 	<ul style="list-style-type: none"> • Flexible water allocation mechanisms • Joint storage projects
	Incomplete Knowledge	<ul style="list-style-type: none"> • Identification of all relevant carbon sources and sinks • Understanding weather-related feedback loops 	<ul style="list-style-type: none"> • Information sharing • Joint scientific research
	Interpretation	<ul style="list-style-type: none"> • Evaluation of scientific evidence • Estimation of distributional aspects of physical impacts 	<ul style="list-style-type: none"> • Scientific boards • Agreement on triggers for policy implementation
Social	Inherent	<ul style="list-style-type: none"> • Population growth rates • Future resource prices 	<ul style="list-style-type: none"> • Information sharing • Cost sharing mechanisms • Markets
	Incomplete Knowledge	<ul style="list-style-type: none"> • Impact of policy mechanism choice • Partners and rivals preferences and bargaining strategies 	<ul style="list-style-type: none"> • Stakeholder engagement • Prior notification rules
	Interpretation	<ul style="list-style-type: none"> • Perception of vulnerability by constituents, rivals, and partners • Risk tolerance / averseness (self and others) 	<ul style="list-style-type: none"> • International law • Conflict resolution mechanisms • Third party arbitration
Technical / Technological	Inherent	<ul style="list-style-type: none"> • Types of future technologies • Future technological needs 	<ul style="list-style-type: none"> • Joint research and development • Third party involvement
	Incomplete Knowledge	<ul style="list-style-type: none"> • Effectiveness of adaptive technologies • Costs of future technologies 	<ul style="list-style-type: none"> • Joint research and development • Third party involvement
	Interpretation	<ul style="list-style-type: none"> • Determination of Best Available Technologies • Equitable distribution of risks and/or cost-sharing 	<ul style="list-style-type: none"> • International standards • Expert panels • Third party assessment

Table 2 – Uncertainties raised by type and party

	Israel	PA	US	Both Israel-PA	Total
Total Uncertainties Raised	17	23	4	3	47
Physical	4	1	2	2	9 (18%)
Social	11	20	1	2	34 (68%)
Technical	4	2	0	1	7 (14%)
Inherent	4	0	1	0	5 (10%)
Interpretation	9	13	2	3	27 (53%)
Incomplete Knowledge	7	10	1	1	19 (37%)

Note: Because some uncertainties belonged to more than one category (e.g., both physical and technical or both inherent and incomplete knowledge), the sum of the figures per category are greater than the figures in “Total Uncertainties Raised.”

Table 3 – The effect of mechanisms for addressing uncertainties on indicators for conflict & cooperation

Indicators for conflict & cooperation	Type of mechanism to address uncertainties				
	Negotiations	Legal	Infrastructure	Data/Study	Other
Power implications	50%	50%	57%	20%	0%
No power implications	50%	50%	43%	80%	100%
Spillover effects	71%	33%	43%	0%	50%
No spillover effects	29%	67%	57%	100%	50%
Change of forum requested	7%	17%	0%	29%	0%
Change of forum not requested	93%	83%	100%	71%	100%
Disputed	50%	67%	57%	20%	50%
Accepted	7%	17%	0%	60%	50%
Neither disputed or accepted	43%	17%	43%	20%	0%
Cooperative	47%	50%	100%	75%	0%
Unilateral	0%	50%	0%	25%	0%
Open-Ended	83%	0%	0%	0%	0%
Reduced Uncertainty	8%	80%	0%	100%	0%
Complete Contract	8%	20%	100%	0%	100%