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Introduction

The world of environmental security is bringing the science of natural resources in ever-closer contact with the policy issues of international stability and foreign affairs. Many U.S. and international agencies—including the U.S. Departments of State and Defense, the North Atlantic Treaty Organization, and the Southern African Development Community—now analyze foreign policy in part through the lens of environmental resources. In October 2001, the Pacific Institute for Studies in Development, Environment, and Security; the Department of Geosciences of Oregon State University; and the Cooperative Monitoring Center (CMC) at Sandia National Laboratories sponsored a workshop designed to highlight the closeness of national security and environmental concerns through explicitly comparing the technologies, institutions, and social issues in two seemingly disparate fields: arms control and transboundary water resources. With generous support from the Carnegie Corporation of New York, "Fire & Water" workshop participants compared and contrasted these two fields and then identified questions for further analysis. Workshop sessions focused on three specific topics: (a) scientific and technological advances, (b) treaties and institutions, and (c) social and cultural issues.

Summary of Key Findings

These two fields are fundamentally different in their structure and outlook. The arms control regime deals with a man-made, artificial resource, and states as the main players. Its significance is political and military, and the somewhat arbitrary rules and norms that have grown up around this regime have meaning only to other players in the regime (e.g., a treaty limit that states that 5,000 missiles make a nation secure but 4,999 do not defines security only subjectively). The water resources regime, on the other hand, deals with a natural resource with ecological and cultural significance. The main players can be states, NGOs, and individual citizens. More importantly, there is a true and objective need for 50 liters of fresh water per person per day (Gleick 1998) as a component of human security.

Nevertheless, both water-resources management and arms control can be the subject of intense international negotiations, and both require a willingness to cooperate and perhaps to make short-term sacrifices to gain long-term benefits. Negotiators for both types of regimes need a general understanding of the initial conditions (e.g., average water-flow or -use data; general military capability) as a critical foundation. Negotiations in both fields must address topics such as lack of trust and/or data, transparency versus opaqueness in process, and appropriate feedback loops and conflict-resolution mechanisms.

Conference participants also explored areas where actors in each field might be able to learn from the other. Arms-control agreements rely heavily on the use of modern technologies such as remote sensing and real time monitoring. Water-resources agreements have not traditionally

applied these types of technology, but could benefit greatly from the objective data they provide. The arms control regime strives to induce every country to sign the same agreements, as a way of promoting universality of international norm. Water treaties, however, involve only those countries that contain part of the disputed watershed, often resulting in innovative regional solutions.. Finally, the water regime has offered far more opportunities for public participation through professional and nongovernmental organizations (NGOs) than has the arms-control regime. Military secrecy regarding arms information and state sensitivity to revealing national security matters has made arms-control agreements generally weak in official opportunities for civic participation.

International Water Resources 101

Two hundred sixty-one watersheds cross the political boundaries of two or more countries. These international basins cover a portion of the earth's surface nearly equal to half of the earth's land, affect about 40 percent of the world's population, and account for approximately 60 percent of global river flow (Wolf et al., 1999). Certain characteristics make management of these basins especially difficult—most notably regional politics that tend to exacerbate the already difficult task of understanding and managing complex natural systems.

Disparities between riparian (containing a freshwater boundary) nations—whether in economic development, infrastructural capacity, or political orientation—further complicate water-resources development, institutions, and management. As a consequence, many people dealing with this regime view treaties and institutions as inefficient, ineffective, and occasionally as a new source of tensions themselves. Despite the tensions inherent in the international setting, however, riparians have shown tremendous creativity in approaching regional development, often through preventive diplomacy.

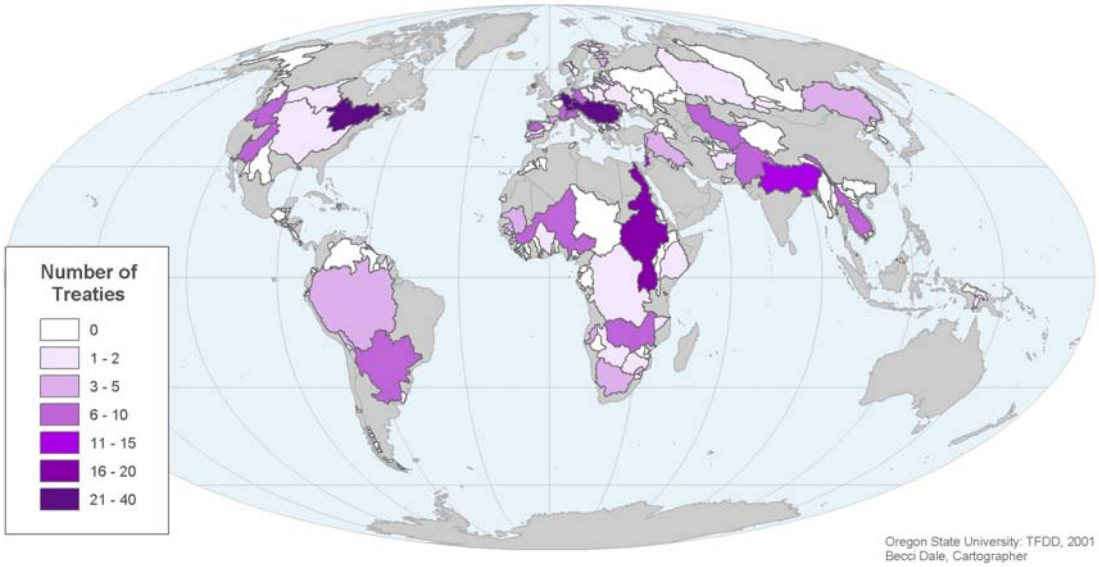
Generalized legal principles for transboundary water management are currently defined by the Convention on the Non-Navigational Uses of International Watercourses, which was ratified by the UN General Assembly in 1997. The Convention took several decades to develop, highlighting the difficulty of combining legal and hydrologic intricacies. Although it provides many important principles, including responsibility for cooperation and joint management, the Convention is also vague and occasionally contradictory. To date, only a handful of water negotiations and treaties have explicitly invoked these principles. The Convention offers few practical guidelines for water allocations—the central issue in most conflicts over water.

In the absence of detailed water law, adequate institutional capacity, or warfare, the countries that contain or border the world's international waterways have managed to "muddle through," creating remarkably cooperative water institutions in the process. In contrast with more general international conventions and principles, these institutions—including bilateral and multilateral agreements, transboundary-management institutions, and unofficial arrangements—have successfully focused on specific regional conditions and concerns.

The Food and Agricultural Organization of the United Nations (FAO) has identified more than 3,600 treaties negotiated between 805 and 1984 relating to international water resources. (The

majority of these treaties deal with some aspect of navigation). Since 1814, nations have negotiated a smaller body of treaties that address non-navigational issues of water management, including flood control, hydropower projects, and allocations for consumptive or non-consumptive uses. The Transboundary Freshwater Dispute Database Project at Oregon State University (http://www.transboundarywaters.orst.edu) houses the largest collection of water-related treaties, including the full text of about 300 treaties that deal with water resources *per se*. Figure 1 shows the world's international basins, along with the number of treaties signed in each.

Figure 1: Number of Treaties per International Basin



Despite their rich history, a reading of these treaties reveals that the legal management of transboundary rivers remains in its conceptual infancy. More than half of these treaties lack monitoring provisions; perhaps as a consequence, two-thirds fail to delineate specific allocations, and four-fifths have no enforcement mechanism. Moreover, the treaties that do address allocations assign a fixed amount to all riparian nations but one, and that one nation must then accept the balance of the river flow, regardless of fluctuations. Finally, multilateral basins are (almost without exception) governed by bilateral treaties, precluding the integrated basin management long advocated by water managers. Nevertheless, once treaties establish cooperative water regimes, they prove impressively resilient over time—even between otherwise hostile riparians and even as conflict wages over other issues.

Arms Control and Nonproliferation Treaties 101

Arms-control and nonproliferation treaties—such as the Chemical Weapons Convention (CWC) and the Nuclear Nonproliferation Treaty (NPT)—are legally binding agreements negotiated between states. In the United States, the President is authorized to sign a treaty, but the treaty will not become law until the Senate has given its advice and consent. In many cases, international organizations manage treaty implementation and perform monitoring and verification activities. However, these international organizations do not make decisions about

treaty compliance. While *verification* involves information collection and oversight activities to ensure compliance with treaty obligations, national governments reserve the right to make *compliance* decisions (i.e., whether treaty obligations have actually been violated).

Most arms-control and nonproliferation treaties have several basic elements, including three critical components: obligations, declarations, and verification measures:

- *Treaty obligations* are the terms of the treaty. For example, the CWC obligates countries not to produce or stockpile chemical weapons. The Strategic Arms Reduction Treaties (START) require the United States and Russia to reduce the number of deployed nuclear warheads. And nuclear testing treaties obligate the parties to refrain from atmospheric nuclear weapons tests and from underground tests above a particular yield.

- *Declarations* are the requirements on treaty parties to disclose information relevant to the treaty's terms about their existing capabilities. For example, a treaty may require parties to declare quantities and locations of weapons, test facilities, and weapon production facilities.

- *Verification measures* are activities and procedures to determine the accuracy of declarations and to verify that parties meet their obligations under the treaty. Depending on the treaty, verification can include the use of satellite imagery, on-site inspections, unattended monitoring, and aerial overflights. Negotiators agree on verification measures (including exact monitoring procedures, specific technologies, and the methods for managing data) in the actual treaty, making them difficult to change, even as new capabilities become available. These measures can be highly contentious, even within a specific country. Because all parties have the same rights of verification and inspection, tradeoffs must be made between intrusive verification and protecting sensitive information. In addition, some countries may agree to treaty membership and/or verification measures as a *quid pro quo*, in exchange for receiving technical assistance or other benefits.

Whereas signatory states generally implement bilateral treaties, international organizations implement many multilateral treaties. Examples include: (a) the International Atomic Energy Agency (IAEA) associated with the Nuclear Nonproliferation Treaty, and (b) the Organization for the Prohibition of Chemical Weapons for the CWC. Responsibilities for these international organizations include: organizing and conducting verification activities, managing and analyzing data collected during verification, and recommending measures to ensure compliance in suspicious circumstances. As mentioned previously, they do not make compliance decisions.

Synthesis 101

The Sandia workshop's goals were (a) to explore each field in the context of the changing definition of security, and (b) to identify useful lessons and tools each set of actors might explore further. Military security—and arms control in particular—has traditionally viewed the state as the object of security. The consequences of compliance and failure redound onto the state. Water

treaties, on the other hand, are often negotiated from the premise that the object of security is no longer solely the state, but includes the people of the state. With almost 3,600 water-related treaties, the water world has a more robust institutional history. Only several dozen arms-control treaties exist, and these have been assessed primarily against classic security parameters.

Yet each regime—arms control and water-resources management—deals with similar issues. A detailed comparison of these two seemingly unrelated fields can illuminate better methods of achieving both state and human security. The similarities are striking, and could lead to the successful transfer of technologies and methodologies from one field to the other. Both water management or allocation and arms control represent interstate issues negotiated between governments; and successful agreements require both an understanding of national and international politics and an atmosphere of cooperation. Both sets of actors negotiate around topics such as lack of trust and/or data, transparency versus opaqueness in process, and appropriate feedback loops and conflict-resolution mechanisms.

The differences, however, are equally striking: water is a shared resource, and water-resources treaties generally involve geographically contiguous states that share an international watershed. Arms are not a shared resource, so arms-control agreements involve states that are not necessarily contiguous. Water management involves resource control and conflicts at the sub-national level, whereas arms of the kind regulated by international agreement have not generally been available to sub-national groups or the public. However, this last point may be changing with the efforts of terrorist groups to obtain biological and chemical weapons.

1. Scientific and Technological Advancements

Summary: Both arms-control agreements and water agreements must start with a clear and shared understanding of the definition of the relevant items or resources. Both must also specify monitoring procedures and verification measures as an integral part of the agreement. However, arms control and water differ markedly in their use of technology for monitoring and verification. Arms-control treaties generally call for extensive use of technology and only allow organizations identified in the treaty to engage in monitoring. Water treaties, on the other hand, generally prescribe neither types of technology nor how the technology will be used to monitor compliance.

Definitions

Establishing and clarifying agreed-upon definitions for terms at the outset of both water and arms-control negotiations can prevent misunderstandings and disagreements throughout the negotiation process and beyond. Successful agreements also require accurate baseline "capabilities and facilities" data. For arms-control negotiations, this refers to the best information possible on each nation's weapons stockpiles and production capabilities. For water negotiations, this can include information on yearly hydrological flows, water-usage data, and water-quality and -quantity information. However, the inherent seasonal and yearly fluctuations in such water data can prove problematic for agreement negotiations. For this reason, water agreements need flexible baselines that can adapt to changing water conditions in the signatory countries.

Verification

Verification is the most critical issue for a successful treaty in either regime, and must be recognized as an integral part of negotiations from the beginning. In addition, the difference between "monitoring" (gathering data on water quality, weapons locations, etc.), "verification" (determining whether a treaty obligation has been met), and "compliance" (deciding whether a party has violated the agreement) is important, because political considerations play a significant role in determining compliance. Importantly, while technological measures, inspections, and other intelligence-gathering methods can greatly increase monitoring capability, merely collecting data does not usually suffice for verification. In arms control, verification decisions usually fall to a political or executive body (such as the State Department or Ministry of Foreign Affairs) within individual countries. For both regimes, a determination of non-compliance does not automatically mean that a country will be charged with a violation. In each case, political, economic, and other considerations intervene.

Negotiating verification is usually the most contentious point for governments, who may hesitate to surrender any part of their national sovereignty to intrusive inspections. The fluctuating baseline issue in the water regime complicates this reluctance, since in years of drought it may be impossible to comply with a treaty based on fixed allocations.

Finally, changing a formal treaty regime to accommodate new technologies and policies can prove difficult. Signatories rarely modify treaty once it has entered into force. Negotiating sides often see last-minute changes or revisions as obstacles to successful treaty completion or attempts by one side or the other to obscure or delay implementation. Surmounting this hurdle requires treaty language stipulating procedures for incorporating new technologies as they become available. Such language permits a mechanism for review and adoption of new technologies.

Technology

Various tools and technologies from arms-control regimes would transfer well to water treaties. Advances in technology (such as remote sensing) originally used in arms control can now find in non-military applications, including hydrologic monitoring. Such technology is likely to play a more significant role in cooperative water-resource agreements in the future. Water-related information portrayed and/or derived from satellite imagery include (but are not limited to) the following: topographic data, evapotranspiration, land use/cover, water distribution/flow, and snow pack (Perry & Kite, 1999; Schultz, 2000). For example, when Wolf et al. (1999) recomputed the numbers and extent of internationally-shared river basins, they used recently declassified digital elevation maps obtained from several countries' military satellite archives.

The complete spatial coverage provided by satellite imagery is especially important in view of the current use of point data to model/portray entire catchment areas (Schultz, 2000). The potential to obtain complete coverage is particularly critical in those developing countries with less-systematic data collection and monitoring. Political sensitivity relating to information sharing also emphasizes the potential role of remotely-sensed data in both international water negotiations (Perry & Kite, 1999) and arms control treaty verification. Given the role that information often plays in negotiations, the perceived objectivity of remotely-sensed imagery may prove critical in dispute resolution.

Moreover, the "real-world" visualization of information provided by satellite imagery may also be valuable in the context of negotiations. While access to new technologies and data cannot replace the political goodwill necessary for creative solutions, user-friendly 21st century technology (such as water systems models, remotely-sensed data, and geographic information systems) can assist in the process of negotiating and managing international water resource systems. In addition, the negotiating sides should make an effort to develop technologies and procedures cooperatively, so that each party has a stake in their deployment and use. Sensitive data should be kept in a secured place to minimize the risk of unnecessary information leakage, and all data gathered for treaty purposes should be accounted for, so as to allay suspicion as to uses of "unused" data.

2. Treaties and Institutions

Summary: Both arms control and water utilize a number of regime structures, from bilateral informal partnerships to formal multilateral treaties. By addressing issues of informational equity and reciprocity and providing significant benefits for participation, negotiating parties can overcome historical mistrust and make progress on critical issues. With the exception of bilateral arms-control treaties between the United States and Russia, both water and arms-control agreements involve almost every country in the world. Arms control, at least in the developed countries, usually benefits from a well-developed bureaucratic and institutional infrastructure that water does not possess. In addition, arms-control agreements benefit from traditional national security funding, whereas water-resources agreements most often do not.

Structure of Negotiations

A variety of (a) formal agreements, (b) informal Memoranda of Understanding (MOUs) and verbal agreements, (c) Cooperative Threat Reduction arrangements, and (d) lab-to-lab partnerships can function to diffuse tensions over both arms-control and water-management issues. These mechanisms can be bilateral or multilateral—though as issues become more comprehensive, more parties may find it in their interest to participate. Additionally, both formal and informal negotiations succeed best when phased in over time, allowing parties to build a history of cooperation and mutual interests. Sometimes, negotiations can utilize an existing institution, such as the United Nations' Conference on Disarmament. The adjudicating institution may also proceed from the negotiations: for example, the International Joint Commission, which was established by the United States and Canada under the 1909 Boundary Waters Treaty to manage transboundary water issues.

Whatever the shape of the arrangement, collaboration over arms control or water resources tends to precede either: (a) a *problem* that makes the *status quo* unacceptable (such as naval confrontations between the U.S. and U.S.S.R. that gave rise to the Incidents at Sea Agreement); or (b) an *opportunity* (such as the decision by the United States to destroy all its chemical weapons, motivating that country to bind others to do the same). For example, a drought can bring countries to the table to negotiate an agreement to prevent or alleviate future water crises. In the early 1940s, negotiations over the Colorado River between the United States and Mexico were accelerated due to both water shortages in Mexico and President Roosevelt's desire to improve relations with Mexico in World War II.

In order to share often-sensitive information about water supply or arms capability, each country must see a benefit to participating in an agreement. However, each country's emphasis on its individual sovereignty often presents a barrier to data sharing and information exchange. By addressing issues of informational equity and reciprocity directly and by providing significant benefits for participation, parties can overcome historical mistrust and make progress on critical issues. Lack of data sharing was an historical barrier between India and Bangladesh in their dispute over the Farakka Barrage on the Ganges River; and their recent formal agreement explicitly calls for exchanges of hydrologic information.

Success of a Treaty
Finally, when parties reach agreement and set up an implementing body, both water resources and arms control can benefit from a clear definition of "success." Some treaties can be declared a success (even in the face of subsequent "technical" violations) because the affected parties negotiated the agreement instead of going to war over the issue. Sometimes the success of a treaty depends on efforts and activities over time rather than on single measures of success. In either case, the development and application of performance criteria can aid in determining the "success" of a treaty or agreement, which can ultimately improve the efficacy of treaties in the future.

Funding
Arms control falls within traditional notions of national security; as such, it is usually very well-funded by governments. But conflicts over water resources—indeed the whole idea of environmental resources and their security implications—fall outside traditional notions of "national security." Because many governments (including that of the United States) have been slow to recognize this "soft" aspect of security, water-resource agreements and negotiations have not been well funded in comparison with "hard" security topics such as arms control. In some instances, international organizations rather than the countries directly involved fund water security activities. The ongoing Nile Basin Initiative, for example, is funded by the United Nations Development Programme, the World Bank, the FAO, Canadian International Development Agency, and the Italian government (http://www.nilebasin.org/nbipartners.htm).

Questions for Further Discussion
The workshop raised a variety of other questions. How do crises become opportunities for negotiation between states? What will bring states to the table to negotiate? How are such a crisis and its attendant negotiations precipitated? Does it require the intervention of an individual to bring about an agreement, such as Jodi Lynn Williams and the international ban on land mines? Or are agreements more likely to be precipitated when the public demands action (such as when the discovery of significant amounts of strontium-90 in children's teeth in the 1950s led to the Limited Test Ban Treaty of 1963)? More specifically, since water is a global resource, should there be a global cooperative water-monitoring agreement? Is this politically possible? Could an international cooperative monitoring program overcome national sovereignty and data secrecy issues, and if so, how? What would be sufficient incentives for countries to cooperate? These questions and others could be the focus of additional work and discussion.

3. Social and Cultural Considerations

Summary: While both water and arms control benefit from public input, the arms-control arena offers fewer opportunities for such input. In addition, public input to reduce both arms and large-scale water-development projects may meet some resistance from governments and other entrenched interests. All forms of agreements can benefit from confidence-building measures, increased transparency, and citizen involvement in verification (if applicable).

Public and NGO Participation

Traditionally, "experts" have negotiated arms control and nonproliferation treaties on behalf of national governments, with relatively little input from the general population. Several factors may have influenced this situation. The regulated or controlled items have generally been military activities and weapons. Government agencies "own" these items and activities. In recent years, treaties like the CWC also regulate material and activities of the private sector. In the case of the CWC, representatives of the chemical industry had a significant though indirect effect on the agreed verification measures. For treaties that concern limiting military equipment and activities, the defense industry can influence decisions through lobbying and other congressional testimony. Water issues also have come under their fair share of lobbying. The recent report from the World Commission on Dams (WCD, 2000) was influenced by representatives from both the dam construction industry and the environmental community. Both sides have challenged its conclusions as biased (Cushing, 2002; McCully, 2002).

Both arms control and water-resource management have experienced an increase in public attention and involvement in decision-making activities in the last few decades, as seen in the rise of nongovernmental organizations (NGOs) throughout the world. For example, NGOs such as the National Resources Defense Council and the Pugwash Conferences have sought to give citizens a voice in matters of nuclear war.

Given the political and military secrecy involved in most arms-control negotiations (as well as the greater role that the public plays in water management as water users), the water field has more public input than arms control does. The water field contains an impressive range of NGOs—from the World Water Council and the Global Water Partnership (whose members include government water agencies, utilities, and private water providers) to the Freshwater Action Network (whose members are other environmental NGOs) to the International Water Resources Association and the International Water Association (which are professional organizations of scientists, engineers, and other water specialists). These organizations can help funnel public input into official government-level negotiations. As arms-control treaties evolve to address issues such as land-mines and small arms—weapons that more directly affect the public—public input will likely rise.

Entrenched Interests

Measuring the input that public citizens should or could have on the formation and execution of policy in the areas of both water management and arms control is complicated by several factors. Both the development and accumulation of powerful weapons such as nuclear warheads and the construction of large-scale water-diversion projects such as dams carry a certain symbolism. Both require a government capable of a certain outlay of wealth and technological prowess; therefore, actions such as these might signal both to other nations and to its own citizens that this

nation is now a world power, a state to be reckoned with. Governments may seek these large technological advancements as symbols of power and progress, thus fueling either an arms race or a development spree. In addition, the more prestige these fields can garner, the more likely they are to develop an exclusive cadre of persons that institutionalize the field's knowledge and viewpoint. Such institutionalization is often accompanied by large-scale industry (and jobs), which increases the number of stakeholders with economic interests in the field. These "entrenched interests" are often resistant to new methods and policies.

Moving Forward

There are several trends in arms control and nonproliferation that may change both implementation and the degree of citizen involvement.

- *Confidence-building measures*, designed to reassure neighbors and the international community that a country is not a threat, need not be legally binding. These measures could include notification of military exercises, invitations to observe military exercises or facilities, and establishing hotlines.

- *Unilateral measures and increased transparency* could be loosely coordinated among countries to avoid lengthy, costly, and contentious negotiations about verification measures. Such an approach could hasten weapons reductions and preserve flexibility.

- *Treaties limiting small arms and other destructive equipment*, such as the Landmines Treaty, have a much greater immediate impact on ordinary citizens than do treaties limiting nuclear weapons. They are also much more difficult to verify. Citizen involvement in treaty initiation, negotiation, and verification could be critical to the success of such treaties.

Non-Treaty Mechanisms

Water-resources management treaties can be supplemented by a number of non-treaty mechanisms, such as cultural festivals, sister watersheds, and trade agreements. People everywhere enjoy celebrating their local water resources, and water festivals have sprung up in venues as far flung as Stockholm, Sweden, and Centerville, Alabama. The 3rd World Water Forum planned for March 2003 in Kyoto, Japan will have a "water fair" associated with it that is expected to bring over 100,000 visitors. The idea of "sister watersheds," along the lines of the common sister-cities programs, has been brought up as a possible UNESCO program to allow communities concerned about their local resources to communicate with other like-minded groups from around the world. All of these types of activities add to local ownership of water-resources issues, and, if harnessed, can further strengthen commitments to international agreements.

Conclusion

What have these two sides learned from one another? With regard to scientific and technological advancements, two things are clear: (a) the strength of the arms-control community in the area of science and technology, and (b) the need for such tools and techniques in the water community. The heavy emphasis on technology found in arms-control treaties would translate well to water-resources treaties. Remote sensing, satellite imagery, and real-time on-line data collection and

dissemination would be extremely useful to determine water availability, flows, diversions, and quality. A recent example began in March 2000, when the CMC participated in a pilot project in Central Asia. Designed to monitor basic water-quality parameters in transboundary watersheds in Central Asia, the project is aimed at "facilitating the development of scientific methodology for cooperation and understanding of transboundary resource issues. This is a precursor to cooperative transboundary natural resource management" (CMC, 2000). By facilitating regional scientific cooperation and collaboration in these newly independent republics of the former Soviet Union, CMC is helping improve regional relationships and promote cooperation on difficult issues that would enhance security and stability in the contentious region of Central Asia.

Arms control again has much to offer with regard to treaties and institutions, although the great number and diversity of water agreements also provide useful tools and concepts. The formalized structures of the arms-control regime give the attendant treaties a high-profile stability and permanence. Organizations such as the (former) Arms Control and Disarmament Agency (ACDA) at the national level and the IAEA at the international level have proven invaluable—both to make sure that governments focus on particular security issues and (in the case of the IAEA) to ensure cooperation among nations facing the same issue. In addition, these types of organizations serve a useful purpose beyond merely fulfilling the functions of the treaty. If the treaty were ever to become defunct, the organization might still fulfill a useful role for information exchange or as a starting point for further negotiations.

The informality of water-resources regimes, on the other hand, offers the flexibility to either: (a) use existing organizations such as the World Meteorological Organization to fulfill treaty functions, thereby making successful treaty execution a less daunting job; or (b) to create organizations for specific treaty obligations (such as the International Boundary and Water Commission, designed to implement the various treaties governing boundary waters between the United States and Mexico). Another piece of knowledge that could be transferred from water regimes to arms control side is that "treaties" themselves might not always be the most useful mechanism to resolve conflict or address an issue. Conflict-management processes and other informal measures may work to overcome mistrust between parties that would otherwise be chary of signing a formal binding agreement.

With regard to social and cultural considerations, experience in water negotiations is deeper and more complex. Water-resources treaties have generally attempted to incorporate public participation and nongovernmental groups more directly in the decision-making process. In a few progressive regional cases, these treaties have adopted cooperative modeling (i.e., including public input in forming assumptions and building models). While most people are still willing to leave technical fields such as arms control to "experts," many NGOs armed with a greater level of knowledge are pressuring governments to display more transparency in these negotiations. Including opportunities for public participation or adopting cooperative modeling may satisfy these demands while permitting negotiations to go forward.

In addition, water-resources projects have increasingly been required to compensate those displaced by dams or affected by poor water quality. Financial compensation for the negative ecological and public health impacts of weapons testing and other weapons development is less

widespread. But non-financial public compensation techniques such as ecological remediation could be transferred to the arms-control regime in response to increased public acknowledgement of the environmental and public health damage from security projects (such as the nuclear weapons production sites at Hanford, WA or Rocky Flats, CO).

Despite their many similarities, we also note two key differences between these two regimes. First, the water-resources regime receives input from many different and often conflicting interests such as agriculture, domestic ratepayers, industry, and ecosystem users. These conflicting interests may make negotiating international water agreements more difficult, since each country might not have a unified position on water issues. While the plethora of voices is a challenge for developing a comprehensive multilateral water agreement, it can also make the final result more robust and palatable. The difficulty of ratifying arms-control treaties in the U.S. Senate reflects in part a lack of broad public participation in their design.

Second, though industrial development can augment a country's biological or chemical production ability, arms-control agreements generally concern static baseline numbers of weapons or capabilities that are limited by the treaty. As such, they can be verified through inspection. Water agreements, on the other hand, may be predicated upon measuring the yearly supply of water in a given watershed, or water quality at specific locations or times. These factors can fluctuate dramatically on a yearly scale because of climatic conditions, or on a longer time scale because of anthropomorphic activity. If such a treaty is to function in reality, its definitions, and verification procedures must take this variability into account.

The unusual comparison of these two seemingly disparate fields reveals many similarities and useful lessons. Comparing other such disparate fields (such as water resources and energy, arms control and food, or arms control and climate change) might offer other lessons of value to help us meet our goals of both national security and environmental protection.

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References

Cooperative Monitoring Center. (2000). Cooperative Monitoring Center, Sandia National Laboratories. [On-line]. Available: http://www.cmc.sandia.gov/Central/centralasia.html

Cushing, Katherine Kao (2002). "The World Commission on Dams report: What next?" In Peter H. Gleick (Ed.), *The World's Water: The Biennial Report on Freshwater Resources 2002-2003*. Washington, DC: Island Press, pp. 149-172.

Gleick, Peter H. (1998). The World's Water: The Biennial Report on Freshwater Resources 1998-1999. Washington, DC: Island Press. 307 pp.

McCully, Patrick. (2002, March 1). Campaigns Director, International Rivers Network. Personal Communication.

Perry, Chris & Geoff Kite. (1999). "Water rights: Importance, difficulties, and new approaches to data collection and analysis." *Water International 24*(4), 341-347.

Schultz, Gert A. (2000). "Potential of modern data types for future water resources management." *Water International 25*(1), 96-109.

Wolf, Aaron T.; Natharius, Jeffrey A.; Danielson, Jeffrey J.; Ward, Brian S.; & Pender, Jan K. (1999). "International river basins of the world." *International Journal of Water Resources Development 15*(4), 387-427.

World Commission on Dams. (2000). "Dams and development: A new framework for decision-making." In *The report of the World Commission on Dams*. London: Earthscan Publications, LTD. 448 pp.