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Afghanistan Transboundary Waters:

Perspectives on International Law and Development

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Front cover image: Kunduz River, Char Dara District, Kunduz, 2017, Image courtesy Jim Huylebroek

About Duran

Duran Research & Analysis is an independent and non-governmental Afghan firm with background in research, strategic planning and program assessment. With the aim of integrating information and learning, providing alternative analytical frames and orienting policy and analysis processes, Duran works in partnership with national, regional and international organizations, and the government of Afghanistan, since its establishment in 2013 in Kabul. For more information on Duran's research activities please visit our website at www.duran.af

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Mohammad Daud Rezaee has an LL.M in transnational business practice law from University of the Pacific McGeorge School of Law in California, USA. Currently he is researching and writing his doctoral dissertation on international law of minimum instream flow with a focus on the 1973 Helmand treaty under supervision of Prof. Stephen C. McCaffrey from University of the Pacific McGeorge School of Law.

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Mr. Ahmadzai has co-authored a book titled Transboundary Water Resources of Afghanistan and has written op-eds and articles for BBC, CNN, Omaha-World Herald and a number of Afghan papers on various political issues concerning Afghanistan, the United States and the region of South-Central Asia.

Mr. Ahmadzai's areas of specialty are Afghan governance, Afghan hydropolitics, tribal dynamics and their impacts on public and their relationship with the government as an institution providing public services based on appropriate public policies. Other areas of specialties of Mr. Ahmadzai are Afghanistan-Pakistan relations, U.S. involvement in Afghanistan and regional security in South-Central Asia.

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His research and work focuses on applying structured approaches to make strategic choices around resource use and policy, and promoting cooperation over shared resource. He has applied this to various sectors including water management, waste disposal, energy, local economic development, biology and conservation. His clients range from local communities, municipalities, regional governments, First Nations, national governments and international organizations. Between 1998-2001 he helped facilitate the Crucible Group: an international multi-disciplinary international think tank on genetic resources.

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Najib Rahman Sabory is assistant professor at Kabul University. He graduated from Electrical and Electronics department of engineering school at Kabul University in 2001. Since then he has been teaching at Kabul University Engineering school. From 2009-2011, he served as the Deputy |Dean for the Engineering School at Kabul University. After a Fulbright scholarship was awarded to him in 2011, he completed a master's degree in Sustainable Energy and a graduate certificate in Project Management from A. James Clark School of Engineering at University of Maryland College Park. At the same time he pursued an MBA program in World Wide Science Academy in Malaysia.

Mr. Sabory was awarded a UNITAR (United Nations Institute for Training and Research) fellowship in 2007 for a period of seven months. He later remained in this program for 2008 and 2009 cycles as coach and resource person.

In 2011, Mr. Sabory led an Inter-Ministerial Commission for Energy (ICE) committee assigned to prepare a capacity building strategy for the energy sector of Afghanistan.

Currently Mr. Sabory serves as Head of the Energy Department of Engineering School at Kabul University. He is a published author in the Energy field.

Table of Contents

Preface

Afghanistan, an upper riparian country, is located at the center of the region's largest renewable sources of fresh waters, making the habitat of the people of this country quite well resourced in terms of access to fresh waters.

Afghanistan has five major river basins with an annual surface water flow of about 57 billion cubic meters. Afghanistan's location as an upper riparian country makes it the source of water flowing into neighboring riparian countries of Iran, Turkmenistan, Pakistan, Tajikistan and Uzbekistan.

However, despite Afghanistan's rich water resources, the sector remains severely under-studied and under invested. Lack of technical knowledge pertinent to this field remains to be a major challenge inhibiting Afghanistan's sustainable development and management of its rivers, particularly aiming at its catalytic role in economic development. Reasons are many. Years of conflict impeded regular data collection and destroyed valuable infrastructure. In addition, the politicization of this issue has discouraged attempts at studying it and understanding it sufficiently. This is while Afghanistan's riparian neighbors built their skills in the area as well as developed their water infrastructure. The consequence of this lack of development in the sector is a wide gap in water specific knowledge in Afghanistan.

As evident from regional and global experiences, sustainable management and development of water resources has the potential to become vital asset for regional cooperation and economic development. In addition to ensuring sustained access to water resources within the country, Afghanistan for example, can secure access to sea and trading ports, to the benefit of both the agricultural and industrial sectors.

To compensate for this lack in capacity and access, it is critical for Afghanistan to draw practical linkages between its water resources and major sectors that contribute a significant deal to economic development, such as agriculture and trade. The Kokcha River Irrigation Scheme for example has the potential to irrigate thousands of hectares of agricultural land in the area, as well as generate thousands of MWs of electricity.

But before we materialize linkages between Afghanistan's water resources and its key economic sectors such as trade and agriculture, it is important to strengthen the structural, institutional, legal and policy foundations of the country in this field.

Of equal significance is shaping the national discourse on transboundary water issues. Unfortunately, there is a dearth of sufficient information and awareness on the role of Afghanistan's water resources in national economic development and on the significance of water resources development and management in improving people's standard of living.

While there are numerous researches conducted by international organizations on Afghanistan's transboundary resources, there are not enough number of researches done by Afghan policy analysts, scholars or academicians.

Afghans have begun to pursue educational careers focusing on transboundary water management or international water law. However, considering the existing capacity gaps and huge potential for knowledge production in the sector, these numbers are in need of urgent increase.

Duran Research & Analysis is proud to present the first issue of the first volume of the Journal of Afghanistan Water Studies, a first of its kind, which comprises of academic analysis with policy implications, mostly developed by Afghan experts of the field. Efforts as these can increase the availability of useful and easily accessible material on the subject for Afghan policy makers in the government, policy analysts and researchers in the civil society sector, and the academia.

This issue of the Journal of Afghanistan Water Studies, a small endeavor in contributing to knowledge base development on Afghanistan's transboundary water resources, includes analysis on topics such as the UN Water Conventions and Afghanistan, role of water in regional dynamics, hydro-cognizance, water security and hydropower.

Duran Research & Analysis is grateful to expert authors of this issue including Mohammad Daud Rezaee, Dr. John F. Shroder, Sherjan Ahmadzai, Dr. Glen Hearns, Mir Sayed Shah Danish and Najib Rahman Sabory for their voluntary contribution. Duran is also thankful to the United States Institute of Peace for financial support to this effort.

Duran Research & Analysis remains committed to knowledge base development and awareness raising on Afghanistan's transboundary waters and will continue to contribute, through these efforts, to sustainable management and development of this valuable asset in Afghanistan.

Abaceen Nasimi
Executive Director
Duran Research & Analysis

The 1997 UN Convention on the Law of the Non-Navigational Uses of International Watercourses

Why does it Matter for Afghanistan?

Mohammad Daud Rezaee

Introduction

The United Nations adopted the Convention on the Law of the Non-navigational Uses of International Watercourses ("the Convention") on 21 May 1997 in an attempt to regulate use, development, management, and conservation of all waters—surface and ground waters crossing national boundaries of states. The Convention entered into force on August 17, 2014. As of February 2017, the Convention had a total of 16 signatories and 36 member States.[1] The Convention is a framework convention that lays down basic principles and procedures and leaves the details to be worked out by member States taking into account the specifics and characteristics of their shared river basins. Some of the member countries include the United Kingdom, France, Germany, Denmark, Sweden, and Hungry (Europe), Iraq, Jordan, Lebanon, Syria and Qatar (Middle East), as well as Uzbekistan (Central Asia).[2] Afghanistan has not yet decided to accede to and ratify the Convention.

Afghanistan is a mountainous, land-locked country in South and Central Asia with "an area of 647,500 square kilometers and population of about 26 million. It is bordered by Pakistan in the south and east, Iran in the west, Turkmenistan, Uzbekistan and Tajikistan in the north, and the People's Republic of China in the far northeast. Afghanistan has an arid and semi-arid continental climate with cold winters and hot summers. The climate varies substantially from one region to another due to dramatic changes in topography. The wet season generally runs from winter through early spring, but the country on the whole is dry, falling within the Desert or Desert Steppe climate classification." [3]

As Afghanistan's Initial National Communication to the UNFCCC puts it "[i]n theory, Afghanistan is not a water-scarce country, and possesses an estimated overall surface water availability of 2,775 cubic meters per capita per year. Nonetheless, it remains burdened by many constraints and the relatively significant amounts of water available in the country hide important variations within and across river and sub-river basins. The distribution of the available water does not always correspond with the location of the irrigable land and the settled populations. And the availability of water in Afghanistan is characterized by considerable intra-

[1] United Nations Treaty Collection (UNTC), available at: https://treaties.un.org/pages/ViewDetails.aspx?src=TREATY&mtdsg_no=XXVII-12&chapter=27&clang=_en

[2] Ibid.

[3] Afghanistan Initial National Communication to the United Nations Framework Convention on Climate Change, p. v, available at:

and inter-annual variations. Further the country also has the lowest water storage capacity in the region." [4]

Afghanistan has five river basins[5] namely Kabul (Indus) River Basin, Helmand River Basin, *Harirud-Murghab* River Basin, Amu Darya River Basin, and the Northern River Basin. Of these river basins, four are transboundary basins that Afghanistan shares with its neighbors: Tajikistan, Uzbekistan, Turkmenistan, Iran, and Pakistan. Afghanistan is upstream to all of these basins except for the *Kunar* tributary river draining into the Kabul lower basin.

Being an upstream state that has not developed its uses of water due to decades of wars and political chaos and instability, now the country desires and desperately needs to fully use its share of water from these river basins for hydraulic power production, irrigation, municipal, industrial uses as well as other economic purposes. At the same time, there are concerns that the prior/historical uses by neighboring countries might be significantly impacted if Afghanistan will use its share of water. The current lack of inclusive regional or bilateral water sharing legal arrangement further adds to the complexity of the situation.

With the entry into force of the UN 1997 Watercourses Convention, Afghans are keen to know that how provisions of this new treaty law – particularly rules stipulated in article 5 ("equitable and reasonable utilization"), article 7 ("obligation not to cause significant harm"), article 8 ("general obligation to cooperate"), and article 12 ("notification concerning planned measures with possible adverse effects") will impact Afghanistan's desire to fully utilize its share(s) of the transboundary river basins. In other words, does the newly adopted Watercourses Convention offer an opportunity for the countries in the region to reach an informed, holistic legal framework for water allocation, management, development, and utilization or it will significantly impact the current *de facto* water allocation regime and further destabilize it?

This paper will briefly examine this question and try to identify a suitable answer that may be used to inform policies and decisions in the coming years.

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[4] Ibid.

[5] Please note that these are administrative basins, as there may be several watershed basins in one "administrative basin". For example the Murghab does not hydrologically connect to the Hari Rud yet they are in the same "administrative basin".

Why does the Convention Matter for Afghanistan?

There are several factors that create debate over the 1997 UN Watercourses Convention in Afghanistan. First, as mentioned earlier, Afghanistan shares four of its transboundary river basins with downstream neighbors. This fact, in the absence of a regional treaty regime, puts Afghanistan in a position that might be significantly impacted by any development in international community regarding fresh water management. In other words, any convention or multilateral treaty entered into force regulating transboundary fresh water at an international level, might, significantly impact Afghanistan.

Second, due to years of political instability triggered by former Union of Soviet Socialist Republics (USSR) attack's on the country, followed by years of devastating internal power struggle, and Taliban ruling on the country for more than five years as well as security concerns, Afghanistan has never been able to reasonably utilize its share of water from the river basins. At the same time, the country has tremendous need to use water for domestic, irrigation, industrial, and hydropower production. According to Afghanistan's Central Statistics Organization, the country currently imports 93.1 percent of its commercial goods[6] including food and agricultural products from its downstream neighbors and purchases hydroelectricity from the central Asian countries (all downstream to Afghanistan) to supply electricity for its major cities including its capital city- Kabul.

Third, Afghanistan is upstream in all its transboundary river basins except in the *Kunar* river – a major tributary of lower Kabul river basin that originates in the *Chitral* mountains of northern Pakistan and after entering into Afghanistan at *Kunar* province drains into Kabul river and then exits the country in *Nangarhar* province. [7] The UN 1997 Watercourses Convention is viewed/perceived by some of the upstream states including China, and Turkey[8] to be favoring downstream states. These are some of the reasons that make the Convention important for Afghanistan.

[6] Afghanistan's Central Statistics Organization

[7] Center For Afghanistan Studies, available at: http://www.unomaha.edu/international-studies-and-programs/center-for-afghanistan-studies/academics/transboundary-water-research/DLM12/DLM12.php

[8] Turkey is upstream to the Euphrates and Tigris river basins. China is upstream to the Mekong river basin.

Does the Watercourses Convention Treat the Upstream and Downstream States Differently?

The second question is whether the UN 1997 Convention approaches upstream States differently from the downstream States. In other words, does the Convention favor downstream countries? Professor Stephen C. McCaffrey, one of the world's leading authority on international water law, who worked on the draft Convention as the UN Special Rapporteur during his two five- year terms and the author of several books and articles on the international watercourses law, holds the view that the UN 1997 Convention does not favor any downstream or upstream riparian State.[9] He considers that the Convention was a regulatory arrangement that could benefit all countries regardless of being upstream or downstream. In the words of McCaffrey if countries want to tell the world that they are not "afraid of law" they should ratify the Convention.

Similarly, another prominent international water law scholar, Salman M. A. Salman also strongly rejects the notion that the Convention favors any particular upstream or downstream State. He says: "… the Convention is basically a framework convention, which lays down basic principles and procedures, leaving the details to the watercourse states to complement in agreements that take into account the characteristics of their specific watercourse." [10]

In order to understand whether the Convention favors any party, this paper will analyze some of the most debated articles of the Convention— articles that have led upstream states to think that the Convention will harm their interest in using water from internationally shared resources. Article 5 that lays down the ("equitable utilization") rule and article 7 that provides for the ("no significant harm") rule are the most contentious articles. These two articles have been heatedly debated during the International Law Commission's drafting process as well as during the UN Sixth Legal Committee's elaborations and even further during the UN General Assembly's meeting that adopted the Convention in the form of resolution number 51/229.[11]

[9] Personal communication with Stephen C. McCaffrey, Northwest Hall, McGeorge Law School, September 12, 2016.
[10] Salman M. A. Salman, The United Nations Watercourse Convention Ten Years latter: Why has its Entry into Force Proven Difficult? P. 7. Available at: http://www.unwatercoursesconvention.org/images/2012/10/Salman-UNWatercoursesConventionTenYears.pdf
[11] UN Doc. A/RES/51/229. Available at: http://www.un.org/documents/ga/res/51/ares51-229.htm

The Equitable and Reasonable Utilization Rule

Article 5 of the Convention provides that: "Watercourse States shall in their respective territories utilize an international watercourse in an equitable and reasonable manner."[12] Article 7 of the Convention, provides that "watercourse States … shall … take all appropriate measures to prevent the causing of significant harm to other watercourse States". Article 5 sets out the fundamental rights and duties of watercourse States in using the shared resources crossing or bordering their sovereign territories. Under this article, States have a right to use water in an "equitable" and "reasonable" manner. In other words, a State has a "correlative" share of transboundary water resource. This means that a State while being entitled to a "reasonable" share of water has a duty not to exceed its rights or deprive other States from their right to a reasonable portion of the shared resource. Now, one might ask what does "equitable and reasonable" utilization mean?

The test for "equitable and reasonable" utilization is set forth in article 6 of the Watercourses Convention. Under this article, the factors for "equitable" and "reasonable" utilization rule includes consideration of the followings:

1) Geographic, hydrographic, hydrological, climatic, ecological and other factors of a natural character;
2) The social and economic needs of the watercourse States concerned;
3) The population dependent on the watercourse in each watercourse State;
4) The effects of the use or uses of the watercourse in one watercourse State on other watercourse States;
5) Existing and potential uses of the watercourse;
6) Conservation, protection, development and economy of use of the water resources of the watercourse and the costs of measures taken to that effect;
7) The availability of alternatives, of corresponding value, to a particular planned or existing use.[13]

Put it simply, under the Convention, if Afghanistan wants to know whether its use of water from Amu Darya, for example, is "equitable" and "reasonable" for the purpose of the UN 1997 Convention, it should check its use(s) against the seven factors/benchmarks listed above and see how the "test" is successfully applied to water uses by Afghanistan and the central Asian riparian States. Ideally, lawyers would use an IRAC-based analytical approach to apply each

[12] The UN 1997 Convention, article 5(1).
[13] The 1997 UN Watercourse Convention, article 6.

element of the test— as appropriate, to each river basin and tell us whether a specific use by a specific water user is "reasonable" or unreasonable. Applying the test to each river basin, in addition to falling beyond the scope of this paper, requires collection of comprehensive, updated, and accurate data and information on each river basin by all riparian States to each basin.

The No Significant Harm Rule

Article 7 of the Watercourse Convention requires a State not to significantly "harm" other states in utilizing its "correlative" share of the resource. This means that a State's exercise of its water right is subject to the "no harm" rule. In other words, if an upstream or downstream state desires to initiate a new use, increase its current use, or build a dam on a transboundary river, the State has a duty not to harm other States. However, one should note that unlike the "no harm" or the "no injury" rule recognized in the national laws of some States/countries for example, California, the "no harm" rule under article 7 of the Watercourse Convention is a "due diligence" obligation. The International Law Commission has defined "due diligence" as "a diligence proportioned to the magnitude of the subject and to the dignity and strength of the power which is to exercise it… and such care as governments ordinarily employ in their domestic concerns".[14] Put it simply, "due diligence" obligation is a "use your best effort" obligation. States have a duty to try their best and do whatever they can, not to harm others in using their share of the water. However, if despite exercising "due diligence" harm still occurs, the country that has inflicted the harm despite being further obligated to cooperate and communicate to mitigate, if possible, the harm but has no obligation to completely eliminate the harm.[15]

There is ample literature and treatises written by the highly qualified publicists and scholars of international law that have discussed the "no significant harm" principle from different perspectives. This paper is not a proper forum for discussing further details relating the no significant harm principle.

Anyway, a closer look at the two articles discussed above as well as a careful examination of the test laid down for the "equitable and reasonable utilization" doctrine, will reveal that the Convention sets forth the fundamental rights and duties of States and leaves the

[14] International Commission, Draft articles on the law of the non-navigational uses of international watercourses and commentaries thereto and resolution on transboundary confined groundwater, p 103, available at: http://legal.un.org/ilc/texts/instruments/english/commentaries/8_3_1994.pdf

[15] See Art 7 (2) that says … " take all appropriate measures, having due regard for the provisions of articles 5 and 6, in consultation with the affected State, to eliminate or mitigate such harm and, where appropriate, to discuss the question of compensation."

rest to States themselves to manage their shared resources. Particularly by looking at the factors laid down in article 6 of the Convention, one cannot find any indication of any favoritism of any kind in that language.

Why Should Afghanistan Consider Signing and Ratifying the Convention?

There are several reasons that I think Afghanistan should consider signing and ratifying or, at least, seriously studying the Convention including:

First, the Watercourses Convention is the result of more than 23 years of work of the most authoritative legal body in the international plane — the International Law Commission (ILC). It draws from the principles embodied in national laws of States, international conventions, international court decisions, and writings of the highly qualified publicists. As mentioned earlier, the most significant provisions set forth in the Convention such as the "equitable and reasonable utilization", the "no significant harm", the "duty to cooperate", and the "prior notification of planned measures" are indeed codification of customary international law that are binding on States regardless of the fact that they have signed and ratified the Watercourses Convention or not. In other words, all watercourse States – including Afghanistan, are already bound by customary international watercourses law to respect the principles of "equitable and reasonable utilization", "no significant harm", the "duty to cooperate", and the "prior notification of planned measures" in using water from shared transboundary watercourses.

There is ample international case law as well as US court cases involving interstate allocation of water that have referred to and applied the "equitable and reasonable utilization" and the "no harm" principles. For example, in the Trail Smelter case (United States v. Canada) the International Court of Justice ((ICJ) ruled that all States had a "duty to protect other states against harmful acts by individuals from within its jurisdiction at all times".[16] In another case decided by the US Supreme Court (New Jersey v. New York) in 1931, Justice Holmes stated that: "[a] river is more than an amenity, it is a treasure. It offers a necessity of life that must be rationed among those who have power over it. … [t]he different traditions and practices in different parts of the country may lead to varying results but the effort always is to secure an 'equitable apportionment'…".[17]

[16] Trail Smelter case, Arbitral Trib., 3 U.N. Rep. Int'l Arb. Awards 1905 (1941)
[17] New Jersey v. New York, 283 U.S. 336 (1931)

Similarly, almost all of international watercourses law scholars and publicists agree that the "equitable and reasonable utilization" principle is now a fundamental norm of international law and therefore a principle of customary international law binding on all States. For example see this excerpt from professor Stephen C. McCaffrey:

> [b]orn of the United States Supreme Court's decision in interstate apportionment cases beginning in the early twentieth century, and supported by decisions in other federal states, the doctrine of equitable utilization was applied to international watercourses as the basic, governing principle by the International Law Association's 1966 Helsinki Rules. Its status as the fundamental norm in the field has recently been confirmed by the decision of the International Court of Justice in the Case concerning the Gabcikovo-Nagymaros Project (Hungry/ Slovakia). … the 1997 UN Convention appears to treat equitable utilization as the overarching principle governing the use of international watercourses….[18]

Another scholar says: " … it [the Convention] has received broad endorsements, and it is widely agreed that it reflects and embodies the basic principles of international water law [customary law]".[19]

Having said this, the most important and overarching principles such as the "equitable and reasonable utilization" and the "no significant harm" rules set forth in the Convention are codifications of international customary law binding on States including Afghanistan. Therefore, accession to, and ratification of the Convention by Afghanistan will not alter the country's legal standing or impose any extra obligation on it.

Second, as the international watercourses scholars suggest, it is in the interest of all watercourse States to sign and ratify the Convention. Because by doing so, States will show to the rest of world that they are not "afraid of law" and they respect principles of international law as "civilized nations" and "responsible States" without being necessarily harmed by these principles.[20] This argument is particularly important for Afghanistan in several ways:

a) Afghanistan is struggling to establish itself as a newly emerging democratic State based on rule of law and good governance since 2001 after the Taliban regime was ousted by the US led Western coalition forces. Since 2002, Afghanistan, in order to establish itself as a responsible State along with other members of the United Nations, has ratified

[18] McCaffrey, Ibid. p 384.
[19] Salman. Ibid. p 13.
[20] Conversation with McCaffrey, September 2016.

dozens of international conventions, multilateral treaties and agreements relating to various areas of international law. History of nations indicate that almost all of new emerging States – including the United States adopted this approach and ratified numerous conventions in the early years of its creation. Therefore, based on this approach, which is not new to Afghanistan, the more international treaties Afghanistan ratifies the more prestige she will gain internationally as a country that respect rule of law and remains at peace with its neighbors.

b) Compared to its neighbors in the region, Afghanistan is a less developed country economically and less powerful State militarily. One of the immediate neighbors with whom Afghanistan shares transboundary river basin is a nuclear power (Pakistan), another neighbor is one of the most powerful States in the region that– allegedly, is in pursuit of regional hegemony (Iran) while others are far more developed economically than Afghanistan (the central Asian countries). Afghanistan depends on all of its neighbors economically and imports 93.1 percent of its commercial goods from or via these countries.[21] This means Afghanistan is not in a position to compete with its neighbors either economically nor militarily. Therefore, the country needs to be at peace with the neighbors and avoid conflict. The more countries, in the region, ratify the Watercourse Convention, the more accountable they would become. This would mean a more stable region with countries bound to principles of international law governing shared resources.

c) As professor Najib Fahim, a prominent professor of Law at Kabul University Faculty of Law and Political Sciences and the author of several books on Afghanistan's transboundary water resources puts it "international law is the law of less powerful States". According to professor Fahim, in practice powerful and hegemon States like Turkey (Euphrates and Tigris river basin), Egypt (the Nile river basin), and China (the Mekong river basin), have shown to attach less importance to principles of international law to claim their water rights from transboundary river basins. Instead, these countries have, unilaterally, developed or attempted to develop mega–infrastructures and development projects aimed at utilizing water from the shared river basins without paying due regards to concerns raised by less powerful States. In the words of professor Fahim, in such circumstances, a very efficient and good tool for less powerful States to create a check and balance for ambitions of the hegemon States is to take recourse to principles of international law and apply the power of law to protect their

[21] Afghanistan Central Statistics Organization, Id.

water rights. As professor Fahim explains, despite the fact that principles such as the "equitable and reasonable utilization" and the "no significant harm" principles embodied in the UN 1997 Convention is at odds with the Afghan traditional perception of transboundary river basins, however, the Convention would serve the best interest of Afghanistan if ratified and will further enable the country to take legal action(s) against some of its riparian neighbors—if the need arises.[22] In Fahim's opinion more legal and regulatory frameworks in the region, would mean further empowerment of Afghanistan to protect its water rights.

d) The level of public awareness among Afghans regarding transboundary shared water resources is dangerously low. Almost all Afghans — including some of the government officials, parliamentarians, politicians, academia, students, and ordinary Afghans think and assert that Afghans own all waters flowing in the country's transboundary rivers.[23] Because these rivers originate inside Afghanistan and drain most part of the country's territory.[24] In other words, Afghans consider water flowing in the country's transboundary rivers as part of their sovereign territory and the public opinion would strongly react against any riparian State that violates this sovereign right. This type of mindset among Afghans coupled with decades of war and fighting in the country, will lead Afghans into another wave of violent struggle with its neighbors if the country enters into serious disputes and conflict with downstream states. Therefore, the best solution is that Afghanistan seeks to ratify international conventions that help the country negotiate with its neighbors over water allocation and adopt a legal approach to resolving serious disputes in the near future. In other words, due to Afghanistan's poverty and political instability, the best approach would be to use the power of law to achieve an equitable and reasonable utilization of its water resources and create a water allocation regime that is acceptable to Afghanistan and the riparian States. The stronger legal framework is developed in the region, the better position Afghanistan would achieve in the negotiations.

[22] Conversation with Najeeb Fahim, a senior Afghan diplomat at MOFA and professor of law at Kabul University, MOFA, February 25, 017, Kabul, Afghanistan.

[23] Most of the ordinary Afghans the author has talked to, told that waters flowing into Afghan transboundary river basins should be treated as property rights and few Afghans think that water resources are shared resources. Almost everyone told that Afghanistan owned the waters.

[24] Conversation with Ebrahim Barekzai, head of Transboundary desk, Ministry of Foreign Affairs of Afghanistan.

e) To date, one out of a dozen countries that share transboundary river basin with Afghanistan has ratified the Watercourses Convention— Uzbekistan.[25] Uzbekistan ratified the Convention on September 4, 2007.[26] This is worth noting that when the UN General Assembly (GA) voted on the draft convention on May 21, 1997, Uzbekistan and Pakistan abstained from voting for or against the draft convention. However, later on, Uzbekistan changed her mind and ratified the convention in 2007. Iran, on the contrary, voted for the draft convention while, Afghanistan, Tajikistan, and Turkmenistan were absent when the UNGA voted on the draft convention. The resolution A/51/L.27 containing the draft convention was adopted by a recorded vote of 103 in favor and 3 against and 27 abstentions by the UNGA.[27]

Interestingly, Uzbekistan is one of the very proactive countries in the region and so far has reached out to many of its neighbors to negotiate agreements over water allocation from the Syr Darya and Amu Darya river basins. Uzbekistan is also heavily dependent on water flow in the Amu Darya and is the largest consumer of water from the basin (over 80%).[28] According to Dr. Glen Hearns,[29] Uzbekistan holds very strong views on water allocation and management that are inherited from when it was part of the Soviet Union. Now that the country has ratified the UN Watercourses Convention, Afghanistan would much benefit from ratifying the Convention in its negotiation with Uzbekistan and other central Asian States. Because, in such a case Afghanistan would only need to go through the checklist provided in article 6 of the Convention to achieve its reasonable share of the water from Amu Darya river basin. In Dr. Hearns view, currently, Afghanistan is not given its equitable and reasonable share of water from Amu Darya river basin, particularly based on its relative socio-economic development compared to other countries in the region. Afghanistan has, arguably, the greatest 'need' to develop its water resources for driving the predominant agriculturally based economy forward and encouraging stability. Moreover, both the Soviet era and post- Soviet (Almaty Treaty of 1992) water allocation arrangements do not provide Afghanistan its reasonable share of water. As Dr. Hearns explains "Protocol 566 (the major water allocation instrument in Central Asia) is

[25] Uzbekistan as well as Turkmenistan have also ratified the Convention on the Protection and Use of Transboundary Watercourses and International Lakes (ECE 1992 Convention) adopted at Helsinki on March 17, 1992. Uzbekistan ratified the convention on September 4, 2007 and Turkmenistan ratified the convention on August 29, 2012. For more details, see UN Doc, available at: https://treaties.un.org/Pages/ViewDetails.aspx?src=TREATY&mtdsg_no=XXVII-5&chapter=27&lang=en

[26] UN Doc. http://internationalwaterlaw.org/documents/intldocs/watercourse_status.html

[27] Id.

[28] Conversation with professor Fahim, MOFA, Kabul, Afghanistan.

[29] Dr. Hearns acted as the Senior Advisor to the Government of Afghanistan on international waters between 2012 and 2014,

based on an estimation of the Amu Darya River having an average of over 70 bcm/year. However the real number is more likely to be between 64-67 bcm. Moreover, climate change estimates indicate that this flow is expected to reduce. There is no provision in Protocol 566 to reassign allocations based on declining flows. Protocol 566 does not take Afghanistan's needs into account and allocates it only 2.6 bcm which is described as a "loss" in the system (while it produces approximately 20 bcm/yr and consumes in the region of 5 bcm/yr). Additionally, Protocol 566 does not allow for sufficient flow to account for environmental needs."[30]

Given the reasons just mentioned above, if Afghanistan – as an upstream State ratifies the Convention first, most of its downstream neighbors will probably be persuaded to ratify it too. This means Afghanistan has taken the first step to create a stronger legal platform in the region to resolve its water issues with neighbors. If such a legal platform does not exist then the challenges of keeping regional stability will increase, particularly with likely effects of climate change.

Does the Position taken by some other Upstream States Matter?

One might argue that, because some of the powerful upstream States such as Turkey and China have refused to sign and ratify the Watercourses Convention, it would indicate that the Convention favors downstream States. Mr. Huseyin E. Celem, head of Turkish delegation to United Nations while voting against the draft Convention in the General Assembly said in his statement "… the draft Convention did not refer to the sovereignty of the watercourse States over the parts of international watercourses located in their territory [and that]. … [t]he draft convention should have established the primacy of the principle of equitable reasonable utilization over the obligation not to cause significant harm."[31] A General Assembly plenary press release summarizes concerns raised by the Turkish delegation as follows:

> Huseyin E. Celem (Turkey) said that his delegation had [been] requested a vote on the draft convention and would be voting against it. The text should have been annexed to the draft, as per established procedure. In meetings with the working group, votes had been taken on draft articles 3, 5, 6, 7 and 33, but the results of those ballots had not been reflected in the Sixth Committee's report.

[30] Conversation with Dr. Glen Hearns, World Bank, Kabul, Afghanistan.
[31] General Assembly Plenary Press Release GA/9248 99th Meeting (AM) 21 May 1997, available at: http://www.thewaterpage.com/UNPressWater.htm

> He said Turkey could not accept the draft convention because of objections to its preamble, as well as draft articles 2(a) and (b), 3, 5, 7, 10 and part III, with the exception of draft articles 11, 22, 23, 32 and 33. As a framework convention, the text should have set forth general principles. Instead, the draft went beyond the scope of a framework [convention] and established a mechanism for planned measures. Such a practice had no basis in international law. The mechanism created an obvious inequality between States. It was not appropriate for a framework convention to foresee any compulsory rules regarding the settlement of disputes, a matter that should be left to the discretion of States concerned.
>
> Further, the draft Convention did not refer to the sovereignty of the watercourse States over the parts of international watercourses located in their territory, he went on to say. The draft convention should have established the primacy of the principle of equitable [and] reasonable utilization over the obligation not to cause significant harm. His country would not sign the draft convention, which would have no legal effect in Turkey. …[32]

According the press release, the Chinese delegation also voted against the draft convention and raised the following concerns:

> Gao Feng (China) said there were obvious drawbacks in the draft convention. First, it failed to reflect general agreement among all countries, and a number of States had major reservations regarding its main provisions. Secondly, the text did not reflect the principle of the territorial sovereignty of a watercourse State. Such a State had indisputable sovereignty over a watercourse, which flowed through its territory. There was also an imbalance between the rights and obligations of the upstream and downstream States.
>
> He said China could not support provisions on the mandatory settlement of disputes that went against the principles set out in the United Nations Charter. His Government favored the settlement of all disputes through peaceful negotiations. Accordingly, he would vote against the draft resolution to which the draft convention was attached.[33]

As one can see in the above text, upstream States like Turkey and China, in addition to other concerns, have traditionally, asserted that the “no harm” rule under article 7 of the Convention will significantly restrict upstream uses. This is because due to geographical, topographical and physical reasons relating to territory of Watercourse States, downstream

[32] Id.
[33] Id.

States have been, historically, in a more advantageous position to put water to use for different purposes. Therefore, downstream States claim historical use right based on prior appropriation of the water.

Upstream States are, usually, located in mountainous regions and due to lack to modern technology and capacity did not have the advantage to use a significant portion of available water in the past. With the modern dam building and water diversion and storage technology, they are now in a much better position to use more water than they did in the past. Using more water upstream means less water flowing downstream. According to upstream States, when there is not enough water available for downstream uses, the downstream States would invoke article 7 of the Watercourse Convention and would claim to have been harmed by new uses upstream. Therefore, the Convention would favor interests of downstream States more than it does for upstream States.[34]

However, this argument can be rebutted in three ways. First, as was discussed earlier in this paper, the most important principles of the 1997 Watercourses Convention are the "equitable and reasonable utilization" and the "no significant harm" principles. As discussed before, these two principles, in no way, favor any particular party and are fully based on mutual cooperation between States.[35] As Salman M. A. Salman, says, States have misperceived the Convention and this has caused the ratification process to be very slow. He asserts: "

> A review of the various statements made by the different delegations during the discussion of the Convention by the Working Group and the UN General Assembly … reveals of a number of different and sometimes inaccurate perceptions and interpretation of the provisions of the Convention. Those interpretations and misperceptions have no doubt contributed to the slow pace of the signing, ratification of, and accession to the Convention.[36]

Second, there are some powerful upstream states like France that have ratified the Convention. Had this argument been true, France should not have signed and ratified the Convention. While on the other hand, there are many downstream States such as Egypt, Pakistan, and many others that have not ratified the Convention. If the Convention necessarily favored downstream States, all downstream States would have ratified it without hesitation.

[34] Salman. M. Salman, Id.
[35] Conversation with McCaffrey.
[36] Salman M. A. Salman, Id.

Third, from the early stages of discussions at the International Law Commission (ILC) over drafting a framework convention on transboundary river basins that further strengthened "crystallization" of the "equitable and reasonable utilization" principle into a general norm of customary international law, both Turkey and China consistently tried to object to crystallization of the norm as customary rule. These objections were made apparently in attempts to qualify the two countries as the "persistent objector" to the "equitable and reasonable utilization" principle to crystalize into a general principle of customary international law. Regardless of the fact that these objections could qualify Turkey and China as "persistent objectors"— the author doubts that they could, the same objections put these countries in a great positional difference from Afghanistan to consider adopting Turkey and China as model countries to follow their footsteps in refraining to ratify the Convention. This is because Afghanistan did not participate in the discussions process of the draft convention over the 23 years period and was absent from the UNGA when member states were voting on the draft convention. Therefore, under international law, under no circumstances, Afghanistan could claim to be a "persistent objector" to crystallization of the "equitable and reasonable utilization" principle as general norm of customary international law and thus not binding the country.

Therefore, States, whether upstream and downstream, would have their own evaluations of the advantages and disadvantages of ratifying the Watercourses Convention based on their national policies and interests. The position taken by any other upstream State does not, necessarily, translate, by itself, into protecting water interests of other States with similar geographical or topographical portfolios. Therefore, positions taken by some of the upstream States regarding the Watercourses Convention would fall short of creating a model position for other States.

Does Ratification of the Convention have any Particular Implication in the Helmand River Basin?

On the Helmand River basin Afghanistan has concluded a bilateral agreement with Iran in 1973. Under this Agreement Iran is entitled to a total of 26 cubic meters per second of water in a normal water year.[37] Afghanistan considers this agreement as enforceable and binding on the two countries. However, Iran has concerns over the validity and enforceability of the agreement. One reason that might discourage Afghanistan not to ratify the Convention is the possible implication of ratification over the Helmand treaty. The truth is that this fear is baseless; because the Convention clearly stipulates that it will not affect any existing agreement or arrangement

[37] The Afghan- Iranian Helmand River Water Treaty, article 2, available at: http://internationalwaterlaw.org/documents/regionaldocs/1973_Helmand_River_Water_Treaty-Afghanistan-Iran.pdf

over water allocation. Article three, of the Convention is very clear about this. As it says: "[i]n the absence of an agreement to the contrary, nothing in the present Convention shall affect the rights or obligations of a watercourse States …".[38] What the convention asks from States regarding their existing water agreements is to voluntarily consider adjusting and harmonizing their existing agreements with principles set forth in the Convention.

Therefore, ratification of the Convention by Afghanistan will not have any implications for the Helmand River Treaty of 1973. As far as the issue is concerned with other transboundary river basins shared between Afghanistan and its neighbors, in the author's view ratification of the Convention, as discussed earlier, not only have any implications for Afghanistan but also paves the way for creation of a legal platform for managing transboundary waters in the region. The author thinks that once such a platform is created following ratification of the Convention, Afghanistan would be among the countries that benefit a great deal from it. This will guide and facilitate Afghanistan's negotiation over water allocation with its neighbors. However, a number of other scholars and Afghan officials the author has talked to while writing this paper expressed different views and insights that will be discussed in the following section.

Views and Insights from Afghan Scholars and Officials

While writing this paper the author talked to several Afghan scholars, diplomats and government officials to ask for their personal views regarding advantages and disadvantages of the UN 1997 Convention for Afghanistan. Following are some of the views shared with the author.

Ambassador Enayatullah, Nabiel, former diplomat and senior advisor to the Afghan Ministry of Finance (MoF) who has worked on Afghanistan transboundary waters for more than a decade, is of the opinion that "in general all Conventions negotiated by the United Nations and/or regional organizations— including the UN 1997 Convention on the Non-Navigational Uses of International Watercourses, are aimed to address competing interest of different nations or their concerns and that as a matter of principle they are not biased towards any nation." However, he thinks that accession to the Convention by Afghanistan "at the present, does not make life easier for the government of Afghanistan— it rather makes life more complicated." In the words of Ambassador Nabiel:

> *Nations normally commit themselves to additional responsibilities and accept new obligations arising from joining (ratifying or acceding) conventions, when they see an outright benefit in doing so, such as protecting their national interest(s). Nations are,*

[38] UN 1997 Convention, article 3(1).

normally, reluctant to create additional headache(s) for themselves by ratifying new Conventions. Due to various reasons, known to our people and the government, Afghanistan has not been able to receive fair share of the water resources generated in our country and need to develop its water resources to enhance economic growth and reduce poverty— an important target of the UN Sustainable Development Goals (SDG). Acceding to the UN 1997 Convention, at the present, does not make life easier for the government of Afghanistan— it rather makes life more complicated. One important reason, that Afghans are reluctant to accede to the Convention in the near future, is because downstream countries to Afghanistan's several river basins, have paid no attention to the needs and rights of Afghanistan when they decided to, unilaterally, develop projects on the rivers flowing from Afghanistan into their territories. I mean they have not played by the rules, and yet to admit it. I think a good and reasonable incentive for encouraging Afghanistan to become a party to the Convention would be to see that international financial institution and donor countries consider funding a number of projects that Afghanistan has in the pipeline and is planning to build, and also urge downstream countries to cooperate with Afghanistan and refrain from creating obstacle(s) for completion of such projects. I am quite sure that the government of Afghanistan firmly believes in using its water resources equitably and reasonably and has no intention to cause any significant harm to any country.[39]

Another prominent Afghan diplomat and water law expert, Mr. Ebrahim Barekzai, who has spent several years working and researching on Afghanistan transboundary river basins, holds that the Convention is an important tool for States to manage their water rights from shared transboundary river basins. However, Barekzai asserted that Afghanistan must seriously study the Convention against each of its transboundary river basins before it decides to ratify the Convention and bound itself by its provisions. Barekzai is of the view that Afghanistan has several transboundary river basins with different characteristics that might be impacted by the Convention differently. According to Barekzai, Afghanistan should conduct a comprehensive study of each of its river basins, consider implications of ratification on each basin and then decide whether to ratify the Convention or refrain from doing so. In the words of Barekzai:

The Convention itself lacks clarity and certainty and suffers some degree of ambiguity in its provisions. Therefore, the Convention was not welcomed, very well, by many countries when opened for signature and its ratification process was very slow. The second issue—

[39] Conversation with Ambassador E. Nabiel at the World Bank Seminar, Kabul, Afghanistan and the subsequent notes sent by him to the author via email.

> *as you might know, lies in the fact that Afghanistan has many problems and other priorities to deal with. This is, probably, too early for Afghanistan to adopt a clear position regarding the Convention. Afghanistan has a lot of homework to do before deciding whether to join the Convention or refrain from doing so at least in the short term.*[40]

There are other scholars who think that Afghanistan would rather accede to and ratify the convention. For example, professor Najib Aqa Fahim from Kabul University who also holds a senior position at the Afghan Ministry of Foreign Affairs (MOFA) and is the author of several books on Afghanistan transboundary river basins thinks that ratification of the Convention has many advantages for Afghanistan. As professor Fahim puts it:

> *In practice, international law is the law of less powerful States. Powerful and hegemon States can protect their water rights and can be at peace with their neighbors through strength. Most often, they do not feel the need to recourse to principles of international law to protect their water rights. For example, China, Turkey, Egypt, and a number of other countries have shown to have bilaterally initiated development projects over shared river basins without being concerned about other riparian States. This is the less powerful States that need to recourse to principles of international law to deter the hegemon states from initiating unilateral development projects over shared river basins and ensure optimal utilization of water resources. Despite the fact that principles such as the "equitable and reasonable utilization" and the "no significant harm" principles embodied in the UN 1997 Convention is at odds with the Afghan traditional perception of transboundary river basins, however, the Convention would serve the best interest of Afghanistan if ratified and will further enable the country to take legal action(s) against some of its riparian neighbors—if the need arises. This is because Afghanistan is way less developed and powerful compared to its riparian neighbors.*[41]

When asked whether Afghanistan was interested to adopt the Convention, professor Fahim indicated that the Convention was mostly codification of international law and already binding on States. In his words, Afghanistan should not act contrary to principles of customary international law codified in the Convention. Professor Fahim said that he, in his capacity as the head of the Law and Treaties Department of Ministry of Foreign Affairs, was working to translate the Convention into Dari so that the Afghan ministries can read and discuss it. Professor Fahim added that since Uzbekistan that consumes a large portion of the water from Amu Darya has ratified the Convention, Afghanistan's accession to and ratification of the Convention would help the country achieve its equitable and reasonable share of the water from the river basin.

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[40] Conversation with Barkezai, World Bank Seminar and the subsequent notes sent via email.
[41] Conversation with Najib Fahim, Kabul, Afghanistan.

Dr. Glen Hearns, holds that if all States in the regions ratify the Convention, the Convention would significantly contribute to conflict management and cooperation over resource allocation as the basket of benefits. However, ratification of the Convention by Afghanistan while having some advantages for the country on some of the basins such as Amu Darya and Kabul river basins might have some implications for Afghanistan on some other basins for example, the Harirud river basin. As Dr. Hearns explains, Salma Dam on the Harirud river basin has been constructed without prior notification of and consultation with downstream riparian States which runs contrary with the principles set forth in the Convention, despite Iran and Turkmenistan constructing the Doosti dam further downstream.

However, the author thinks that this position taken by Dr. Hearns regarding the Harirud river basin could be counter- argued as follows:

First, the downstream riparian States to Harirud river basin — Iran and Turkmenistan, have concluded several treaties including the 2003 and 2005 Friendship Dam construction agreement without notifying Afghanistan. This has put Afghanistan in a position to adopt towards these two riparian States an attitude of complete “reciprocity” and resume construction of Salma Dam without prior notification of the riparian States. “Reciprocity” is a well-known principle of international law that enjoys global recognition. The principle of reciprocity is unilaterally applied by one State to induce compliance by another States.

Second, some of member States to the UN 1997 Convention have asserted observations or declarations to the Convention upon accession or ratification. For example, Syria, Hungry, Viet Nam, Netherlands, and Denmark have asserted their own observations while ratifying the Convention. For instance, the reservation made by Denmark reads: “Territorial Exclusion: Until further notice, the Convention shall not apply to the Faroe Islands and Greenland.” Adopting international conventions with asserting observation(s) regarding some of the articles provided in those conventions is a common practice in international plane. Therefore, if Afghanistan wishes to ratify the Convention, without any possible implications on any of its river basins, it could exclude the Harirud river basin from the scope of the Convention’s application through asserting an observation upon ratification. This way, Afghanistan could take advantage from principles of international law without being necessarily harmed by the Convention.

Conclusion

Afghanistan shares four of its five transboundary river basins with its neighbors. Given the fact that there is no regional and bilateral regulatory framework that can facilitate an “equitable and reasonable” allocation of water between Afghanistan and the other downstream States, the UN 1997 Watercourses Convention might offer the best and unique opportunity for the country to ratify it and take the first step to creating a holistic transboundary regulatory regime for the region.

The UN 1997 Watercourses Convention is the result of more than 23 years of efforts made by the most authoritative international legal body – the International Law Commission (ILC). The most important principles set forth in the Convention such as the “equitable utilization”, “no significant harm”, and “prior notification” is a codification of customary international law already binding on States. Ratification of the Convention not only does not impose any extra legal obligation on Afghanistan but also protects its “correlative” water rights against its powerful neighbors. Given the fact that Afghanistan is way less developed and enjoys a less advantageous economic and military position in the region, the country must avoid resorting to any conflict and instead use the power of law and international courts to use its equitable share of transboundary resources.

The principles of “equitable and reasonable utilization” and the “no significant harm” sets out the fundamental rights and obligations of Watercourse States in regard to transboundary rivers crossing or bordering their sovereign territories. The “equitable and reasonable utilization” doctrine, through applying a specific “test” under article 6 of the Watercourse Convention, recognizes the “correlative” rights of States to use water. The “no significant harm” doctrine imposes a “due diligence” duty on States not to harm others while using their “correlative” rights of a shared resource.

Ratification of the Watercourses Convention would strengthen Afghanistan’s position, as a responsible and accountable State, amongst other members of the international community and in the region. It would also enable Afghanistan to invoke power of international law and jurisdiction of international courts to protect its direly needed water rights. Positions taken by other upstream States in refraining from signature or ratification of the Watercourses Convention fall short of creating a good model for Afghanistan. If Afghanistan desires to provide hydropower electricity and feed its people through investing in water resources and at the same time be at peace with its neighbors it must act in compliance with international law and resort to the power of law.

Hydro-Cognizance

Water Knowledge for Afghanistan

John F. Shroder & Sher Jan Ahmadzai

Abstract

Water knowledge for Afghanistan is the idea of increasing the overall status of information and understanding about the most essential material that enables all life anywhere on Earth. Such hydro-cognizance is required at all educational levels in order to increase intelligent awareness so as to overcome decades of inattention because of war and general ignorance. The Afghan citizenry cannot yet depend upon its leaders to steer a fruitful course through the uncharted waters of uncertainty. Many things cause problems, such as changing climate, water shortages, external political machinations over water, and a fraught future of diplomatic ignorance about water, and even the possibilities of increasing water wars in arid Southwest Asia. An important solution of a water pedagogy has been developed under the rubric of sustainable development. This teaches about the critical substance at many levels from elementary water schools for toddler children, up through higher-order water education for sustainable development (ESD) at secondary and university levels to include scientific and technical hydrologic engineering. Multiple perspective approaches (MPA) have been developed to include eight major approaches: (1) scientific; (2) historical; (3) geographic; (4) human rights; (5) gender equality; (6) values: (7) cultural diversity; and (8) sustainability. Core recommendations on water education in Afghanistan are required to help the country develop a cadre of well-educated, water professionals who are committed to carry their country forward into a more hopeful future where access to safe water is better assured.

Introduction

The subject matter concerning knowledge about the most essential fluid that exists on planet Earth is actually an enormous group of topics that deal with all the diverse matters a person needs to know about the aqueous material. Inasmuch as water is so essential to all life, especially to us humans because of our special intellectual attributes, a huge variety of academic disciplines and sub-disciplines have been developed to address the most important information concerning the relevant topics about water. For example, water can be studied in a great variety of academic disciplines, including the sciences of physics, chemistry, environmental biology, geology, and geography, as well as three of the three main categories of engineering, such as chemical, civil, and mechanical engineering. In fact, in the sub-disciplines of engineering, the utilization of water in the different realms of agricultural and urban water uses require special attention. Similarly, the manipulation of water throughout antiquity has been fascinating to assess in the fields of archaeology and anthropology. In the other non-sciences, virtually any of the standard academic disciplines of history, sociology, religion, economics, political science, diplomacy, and many other types of inquiry have areas for assessments of the role of water. In fact in any university setting in those arid regions of the world that are most worried about the implications of climate change and the diminution of their water supplies in future, the development of new curricula in many disciplines would seem to be highly advisable. This paper is a discussion of the great diversity implicit in the study of water and the best means to study and achieve knowledge about the topic that will be of the most use to people having to solve real problems with their own water supplies.

Water is often considered to be the universal solvent; that is H_2O is the material that will dissolve almost anything. This fact is a kind of metaphor for the near universality and utmost importance as the water of all life and for all life. In fact, although non-aqueous life forms can be conceived of as existing on planets far away from us, astronomers often talk about the habitable zones of stars wherein the existence of the phases of liquid and gaseous water are, of course, known on Earth to be an absolute requirement for all life as we know it. Thus in the so-called “Goldilocks Zone” of planets, where according to the children’s tale, little Goldilocks finds things to be just right for her, so also we humans and all our life-supporting other plants and animals know that water makes things just right for us. So we must not run out of that essential fluid. We need to know as much as we can about this miraculous substance; about its physics as much as we can understand, and about its legions of other qualities, as much as we can comprehend. Only by paying attention to all of its vagaries, all of its strange peculiarities, and about its many conditions of existence and manipulations by humans, can we hope to deal with it effectively in these times of burgeoning human populations and so many threats to our access to the life-giving material.

In recent years since the 20th century of the Common Era (CE), water has come to be recognized as the single most critical material to be more-or-less available to the humanity of the future. This fact has become a major point of mobilization of many societies in which to engage the youth of any country. Accordingly a host of water-fact sheets, water-educational programs, and water-alert warnings have been designed and implemented in various forward-thinking regions and vulnerable nations. In a strong sense, ever since the US national Earth Day efforts and environmental agitation of the 1960s and 1970s that led to various green parties and other strong environmental efforts worldwide, water problems are increasingly being recognized by ever more people as needing increasing special attention. These factors of increased recognition mean that countries in south and central Asia and the Middle East, in particular, are increasingly recognizing their exceptional vulnerabilities in the water sectors. As a result, these nations are rising to the occasion and trying to come to terms with the severe problems that they all have with their water.

By the late 20th century, recognition had come that the future of a healthy planet must become one that is not consuming itself through the actions of far too many greedy humans over anything else. This has led to new concepts of sustainable development in which human development goals can be met, while at the same time sustaining the ability of natural systems to continue to provide the natural resources and ecosystem services upon which all societies and economies must depend. To achieve this objective 17 global goals for sustainable development were advanced by the United Nations (2015) (Table 1), some of which were rather lofty, although certainly all are good hearted. Two are directly focused on water; number 6 on clean water and sanitation (Table 2), and 14 on life below the water surface, but certainly several of the others speak indirectly to water, such as number 13 (Table 1) on climate action, and number 4 (Table 1) on a quality education from where the knowledge to attend to the water in any country in the world must be derived.

Table 1. The global goals for sustainable development from the United Nations in 2015 (http://www.un.org/pga/wp-content/uploads/sites/3/2015/08/120815_outcome-document-of-Summit-for-adoption-of-the-post-2015-development-agenda.pdf - accessed 3/1/2017).

1. No poverty
2. Zero hunger
3. Good health and well-being
4. Quality education
5. Gender equality
6. Clean water and sanitation
7. Affordable and clean energy
8. Decent work and economic growth
9. Industry, innovation and infrastructure
10. Reduced inequalities
11. Sustainable cities and communities
12. Responsible consumption and production
13. Climate action
14. Life below water
15. Life on land
16. Peace, justice, and strong institutions
17. Partnerships for the goals

Attention to Table 2 from the point of view of actual conditions in the field and the possibilities of being able to produce the eight major changes in the next three (2020) to thirteen (2030) years as specified, shows the high improbability that anything remotely like several of these stated goals can really be achieved. For example, in widespread areas in Afghanistan, or several of the surrounding countries either for that matter, achieving universal access to safe and affordable drinking water for all is highly unlikely. Eliminating open defecation there is quite unlikely as well, and producing adequate and equitable sanitation hygiene for everyone, much less for women and girls, is equally unlikely. On the other hand, certainly some progress can be made in a number of the other factors suggested in the attempts to clean up their water. The goals of the United Nations and other such agencies, laudable as they may be, are also somewhat fraught with a certain lack of realism that unfortunately may detract from the overall good work being done. Perhaps this is actually a well thought-out approach, and the reality is, that an approach of always promoting more than can be obtained, is thought to be somehow the wisest course. The danger seems to be also, however, that the process of such an approach will always leave out some parts of the society of the world. In this fashion, the end members of certain groups of poor countries are not likely to ever be able to reach such proposed goals. Because water is so critical to all humanity, however, leaving any poor country out of the goals entirely, because they are so unobtainable for that particular benighted place, is not a position that can be much supported in the development milieu. Thus in the case of Afghanistan, even though some of the UN's goals about water there are quite unrealistic in the short term, still in the long view strong attempts must be made to alleviate as many water problems in the country as possible.

Table 2. The goals of the United Nations to attend to making clean water and sanitation universal in the world to ensure sustainable development (http://www.un.org/pga/wp-content/uploads/sites/3/2015/08/120815_outcome-document-of-Summit-for-adoption-of-the-post-2015-development-agenda.pdf - accessed 3/1/2017).

6.1 By 2030, achieve universal and equitable access to safe and affordable drinking water for all.
6.2 By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations.
6.3 By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater, and substantially increasing recycling and safe reuse globally.

6.4 By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity.

6.5 By 2030, implement integrated water resources management at all levels, including through transboundary cooperation as appropriate.

6.6 By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers, and lakes.

6.7 By 2030, expand international cooperation and capacity-building support to developing countries in water- and sanitation-related activities and programs, including water harvesting, desalination, water efficiency, wastewater treatment, recycling and reuse technologies

6.8 Support and strengthen the participation of local communities in improving water and sanitation management.

Alleviation of even minimum water problems in Afghanistan and other nearby areas in large part must rely upon plentiful discussions and as much practical action as possible to make even a minor dent in the problem, much less for a more desirable, and many would say, even a critical necessity for overcoming the negative situation. Full-scale attempts must be made in Afghanistan to begin to make progress on healing some of the identified problems. Teaching about water must take place in a large number of places and with a great variety of different methods in order to even make minimal progress.

Water Education and Capacity Building

Water Pedagogy

Basic pedagogy is made up of the methods and practices of teaching, especially as an academic subject or as a theoretical concept. The pedagogy of water, therefore, is the building of better intellectual, in-depth knowledge, and practical-user capacity in people, in faculty, and in students at all levels to become more knowledgeable about water. This is done so that all of the many aspects of water can be dealt with in more appropriate fashions than has happened in most of South and Central Asia in most past decades. In fact, water education and capacity building about it are absolutely essential to all countries, but most especially in arid countries such as Afghanistan and its surrounding region It is also quite likely that one of the reasons that water has not ever received such centralized attention in the past is because the topic was always regarded as too widespread in everything, so therefore too diffuse to study except as rather peripheral material that was perhaps somehow thought too obvious to study in detail. It

was everywhere but nowhere, perhaps. And water was also certainly not, or apparently not in any sort of mainstream intellectual or philosophical center in most universities, for example. This is probably because the subject of water was not in any sort of systematic *logos* as in a "waterology' or "aquology" so the topic could not easily compete as a standard university department, with the result that no real pedagogy of water has existed until very recently, and then still only at the most elementary levels (Horvath, 2016).

Traditionally in university settings world-wide whenever a topic of research and education needs to be newly emphasized, the standard way to accomplish that is the formation of a **Center** or perhaps a **School** of the particular topic at hand. In this case in Afghanistan where water is being newly emphasized as a topic essential to the country, the formation of a whole new group of ways to study the fluid in all the most necessary ways appears to be required. Everyone seems to recognize that strong university and various efforts in different ministries are required to bring local knowledge about water back up into something that can be relied upon in the government. Water engineering is a prime focus of much effort, although some of this work can be rather deficient because the prior educational capacity has been so limited for many years of warfare. Less well understood, however, is the need or even ability to get education about water down into the elementary schools for childhood where so many useful advances can be made. Wholesale educational redesigns need to be made throughout all the primary schools about water in the country. In fact conversations should be had with the most respected religious and legal authorities in the country to start up new educational programs about water, or revamp old ones.

Water School

In this fashion the redesign of the educational system of Afghanistan to accommodate water in many new disciplinary areas is certainly worthy of discussion. In all probability, however, given the natural inertia in all societies to reconfigure any essential aspects of society such as education or government, total overhaul is not likely to happen. Thus the most likely development will be some changes to curricula of higher education and the formation of one or more institutes or centers specific to water studies. Nonetheless, Horvath's (2016) discussion of using topics focused around aspects of water to engage young children in thinking in many different ways in their earliest education is a most intriguing idea. Her Water-School approach (Table 3) provides a unique environment for the learning and development of children, although many of its suggested out-of-doors aspects in the unpredictably violent and hyper-arid Afghanistan would present a great many impossible barriers to a number of its suggested teaching examples. With clever adaptations to local conditions, however, some of the recommendations in the book can be met for teaching some young people in Afghanistan.

Table 3. Chapter titles for Horvath's (2016) new ideas on formation of Water Schools for nursery and primary education of young children.

1. The origin and validity of Water School
2. The environments and ecosystems of Water School
3. The pedagogy of Water School
4. How children learn holistically in Water School
5. Health and safety in Water School
6. The Water School leader in training
7. International examples of education through natural water

Examples of practical Water-School education for young children include ideas for learning in the outside world that cover such topics as wildlife, sensory activities, crafts, social development, physical play, and simple play construction in different seasons. This includes unique teaching tools to observe and develop the children, as well as ideas for working with children of different ages and learning styles. At the same time, a very useful tool could include detailed guidance on health and safety concerning water, including risk assessments. In these fashions, because everyone, even in hyper-arid environments, must utilize at least some water every day, access to water in such learning environments should be possible, even in Afghanistan.

The idea of a pedagogy of water designed to promote better understandings of this vital material in contemporary society in a place such as Afghanistan may seem somewhat strange at first. If the topic is considered in the context of the modern condition of how hard it is to obtain at all in so many places, perhaps reasons for focusing on it will be more obvious. In any case, the very notion of a water pedagogy is most likely strange to people everywhere. At its very base is the fact that pedagogy itself is the method and practice of teaching, especially as an academic subject or theoretical concept, so in this case water pedagogy would just be the idea of teaching about water. As mentioned at the outset in this paper, teaching about water is a hugely diverse subject spread throughout a great many traditional academic disciplines. Teaching with water as a focal point, on the other hand, can even be considered as a whole different thing, especially for educating young children. But teaching with water in a country such as Afghanistan is also a most difficult proposition, given the great difficulties of using water inside a classroom, or in any sort of field work for reasons of security and cultural necessities. Nonetheless, in regards to water, Afghans are highly sensitive to their diverse vulnerabilities at all age levels, as well as their cultural shortcomings in dealing with many old, even ancient, efforts to have access to water for whatever purposes. The result is a variety of means to deal with such problems might be possible if local teachers use their imaginations to find ways to teach children about water.

Water School at the elementary level is a kind of nature education where children learn about natural forms of water – such as water puddles, rain, snow, frost, or at higher educational levels – snow banks, glaciers, rivers, lakes, the oceans. Then in being asked to consider the many forms of water, the children are taught to think about: (1) how orderly nature is; (2) how water changes so much in short periods of time; and (3) how nature accepts such changes so freely. In this fashion, a sense of *freedom* becomes an essential part of education in Water School. Afghans are among the most freedom-loving people in the world, so in this sense linking water and freedom to children is a very natural way to engage them. Horvath (2016) has made this linkage quite explicit, pointing out that in Water School education, freedom is a complex right that includes freedom of movement, thought, and activity. This will also include freedom of choice and respect toward the freedom of others, which – inevitably - includes order in society. These ideas can be developed in many ways by teachers to be compatible to local situations to help in their teachings. Playing in or with water is also a natural thing for children to do as they learn about life. If teachers engage the children in different kinds of play with water to think about mixing water in dirt to make mud, everyone knows about how little children love to play with mud or to jump in puddles after a rain. Sliding on ice is another aspect of child's play that can be developed by thinking teachers. Almost anyone can think of myriads of ways for children to play in different ways with water in all of its different forms and conditions. In these fashions a new emphasis on developing a pedagogy on water in Afghanistan can be developed at a national level in Afghanistan, beginning at these lower levels and eventually including all the higher levels as well.

Water Education for Sustainable Development (EDS)

The United Nations Educational, Scientific and Cultural Organization (UNESCO, 2012a) has recognized for a number of years that water education is key to achieve millennium development goals (MDGs) worldwide. Accordingly they have established a number of objectives to achieve their mission of establishing an integrated understanding of biological and hydrological processes at a water catchment's scale in order to create a scientific basis for a new, cost-effective and systematic approach to the sustainable management of freshwater resources. Water education is thus seen as the strategic entry point in developing a new ethic for water governance and management, a factor now recognized as absolutely critical for the future of a country such as Afghanistan. As is well recognized, however, a great many challenges exist in providing water education for sustainable development. Thus in order to shape a new generation of water managers and decision makers who are able to apply holistic and multidisciplinary approaches to water resources in Afghanistan, new educational programs must be developed. This must include dramatically improved linkages between those engaged in water education at the highest university levels, down through those working in elementary

and secondary schools, vocational education and local training courses, and community levels, including the mass media (radio, television, newspapers, and so forth). In an assessment of exactly how to do this UNESCO (2012a) performed a SWOT (strengths, weaknesses, opportunities, threats) analysis of water education at all levels to find generalized conclusions and key messages for each education area (Table 4)

Table 4. SWOT analysis of strengths, weaknesses, opportunities, and threats to water education at five levels in any society (UNESCO, 2012a).

1. Tertiary (higher) education and professional development of water scientists, engineers, managers, and decision makers.

- Take a bottom-up approach before going to regional level.
- Establish incentives for Afghans to stay in country, and to return after external education.
- Work with successful existing networks.

2. Education and training of water technicians.

- Water training centers should play a major role.
- Training needs to be strategically linked with career path and instructional needs.
- Technical training needs to be well-grounded in basic knowledge, reflection, and innovation.

3. Water education in schools.

- A role for NGOs exists in this area, to potentially partner with local government and universities, as is being done to a certain extent in Afghanistan.
- Examples of such NGO partnerships from elsewhere that have been successful should be found and followed.

4. Community education

- Water price is a key problem so communities need to better understand the costs of water.
- Communities need to be educated to be able to discuss infrastructure and development projects that affect them.
- Communities have their own indigenous knowledge about water that needs to be discussed at the outset.

5. Water education for mass-media professionals

- Media people should be brought along to all major water events.
- Water professionals should take the first responsibility of committing to communication with the media, not the other way around.

Multiple Perspective Approaches (MPA) to Learning about Water

In addition to the idea of using water education for sustainable development (UNESCO, 2012a) as discussed directly above, UNESCO (2012b) also strongly suggests that learning about water must be approached from multiple viewpoints if any hope exists to ever achieve that goal of EDS. Thus in order to educate for the sustainability of water in any place, especially the drier reaches of Afghanistan, the teachers must educate about how water is used, valued, governed, and reserved throughout the country. The teachers can avail themselves of sufficient information to do this, providing that they can read English and have access to the internet.

Table 5. Information sources in the English language concerning water available on the internet online (from UNESCO, 2012b). All of these internet resources were accessed on 3/2/2017, but a number of the original sources listed had been removed from the internet in the five years since first publication by UNESCO.

GENERAL WATER WEBSITES

National Geographic, "Freshwater" - http://environment.nationalgeographic.com/freshwater/
Water for the Ages - http://waterfortheages.org/
WaterWorld - http://community.waterworld.com/
Running Dry - http://www.runningdry.org
Imagine H2O - http://www.imagineh2o.org/
International Decade for Action "Water for Life" 2005-2015 - http://www.un.org/waterforlifedecade/
The Water Project - http://thewaterproject.org/
World Water Day - http://www.worldwaterday.org/
World Water Council - http://www.worldwatercouncil.org/
World Water Assessment Programme - http://www.unesco.org/water/wwap/

WATER WEBSITES FOR CHILDREN

Learn about Water Discover Water Project – http://www.discoverwater.org/
USGS: Water Science for Schools - http://ga.water.usgs.gov/edu/
Kidzone: The Water Cycle - http://www.kidzone.ws/water/

Science Kids - http://www.sciencekids.co.nz/sciencefacts/water.html
EPA: Water Kids - http://water.epa.gov/learn/kids/waterkids/kids.cfm
Water Education Foundation: Water Kids - http://www.watereducation.org/water-kids
Natural Resources Defense Council: For Kids - http://www.nrdc.org/reference/kids.asp
Kids R Green - http://www.kidsrgreen.org/
Eartheasy, Environmental Websites for Kids - http://eartheasy.com/blog/2009/03/environmental-websites-for-kids/

WATER WEBSITES: TEACHING RESOURCES

Project Wet - http://www.projectwet.org/
The Water Project - http://thewaterproject.org/resources/
Water Aid Learn Zone – http://www.wateraid.org/international/learn_zone/
Water for All: Oxfam Education – http://www.oxfam.org.uk/education/resources/water_for_all/water/gettingstarted.htm
Water Rights and Wrongs by Young people of the World - http://hdr.undp.org/en/media/water_rights_and_wrongs_english.pdf
Project Learning Tree - http://www.plt.org/
Kids for Saving Earth - http://www.kidsforsavingearth.org/
Facing the Future - http://facingthefuture.org/
Australian Water Education Toolkit – http://www.environment.gov.au/water/education/
International Year of Chemistry - http://water.chemistry2011.org/web/iyc/experiments

WATER WEBSITES: TOOLS AND RESOURCES

National Geographic, Water Footprint Calculator - http://environment.nationalgeographic.com/environment/freshwater/water-footprint-calculator/
National Geographic, Signs and Solutions - http://www.nationalgeographic.com/signsandsolutions/
The World's Water - http://www.worldwater.org/
Learn about the Water Crisis - http://www.onedrop.org/en/UnderstandTheWaterCrisis/water-crisis.aspx
Aqua, a Journey into the World of Water - http://www.onedrop.org/en/projects/projects-overview/AquaNorthProject/SchoolZone/YouthsCorner.aspx
Educating Young People About Water – http://www.uwex.edu/erc/eypaw/
Water Resources Education - http://clean-water.uwex.edu/

WATER WEBSITES: ARTICLES

Tunza Magazine: Water – http://www.ourplanet.com/pdfs/Tunza_6.3_EN.pdf

National Geographic, "Water: A Special Issue" - http://ngm.nationalgeographic.com/2010/04/table-of-contents
Nature, "Global Water Crisis" - http://www.nature.com/nature/focus/water/
New York Times, "Water Pollution" - http://topics.nytimes.com/topics/reference/timestopics/subjects/w/water_pollution/index.html
Global Issues, "Water and Development" - http://www.globalissues.org/article/601/water-and-development
NASA Earth Observatory, "The Water Cycle" - http://earthobservatory.nasa.gov/Features/Water/

WATER VIDEOS: DOCUMENTARIES

TheWaterChannel – http://www.thewaterchannel.tv/
Flow: For Love of Water (2008) - http://topdocumentaryfilms.com/flow-for-love-of-water/ and http://www.flowthefilm.com/
A World Without Water (2006) - http://topdocumentaryfilms.com/the-world-without-water/
Between the Tides (2009) - http://lifemorenatural.com/?p=371
Blue Gold: World Water Wars (2008) - http://topdocumentaryfilms.com/blue-gold-world-water-wars/
Waterlife (2009) - http://waterlife.nfb.ca/
Tapped (2009) - http://topdocumentaryfilms.com/tapped/ and http://www.tappedthemovie.com/
One Water (2008) - http://www.onewater.org/movie
Running Dry (2005) - http://www.runningdry.org/what.html

WATER VIDEOS: SHORT CLIPS AND PHOTOS

National Geographic, "Why Care About Water?" - http://video.nationalgeographic.com/video/player/environment/habitats-environment/freshwater/env-freshwater-whycare.html
TED, Michael Pritchard's Water Filter Turns Filthy Water Drinkable - http://www.ted.com/talks/lang/en/michael_pritchard_invents_a_water_filter.html
Life is Water - http://www.jennwarren.net/#/life-is-water and http://www.youtube.com/watch?v=CkxLWHrh2io
Time, "World Water Crisis" - http://www.time.com/time/photogallery/0,29307,1724375,00.html

WATER ORGANIZATIONS

UN-Water – http://www.unwater.org/
UNESCO Division of Water Sciences – http://www.unesco.org/new/en/natural-sciences/environment/water/

UNESCO Institute for Water Education (UNESCO-IHE) - http://www.unesco-ihe.org/Education
International Hydrological Programme (IHP) – http://www.unesco.org/new/en/natural-sciences/environment/water/ihp/
Charity: Water - http://www.charitywater.org/
International Secretariat for Water (ISW) - http://www.sie-isw.org/
Alliance for Water Education - http://allianceforwatereducation.org/
Water.org - http://water.org/
Global Water - http://www.globalwater.org/
Global Water Initiative - http://www.globalwaterinitiative.com/
Water Environment Federation - http://www.wef.org/

Because this will not be the case for many of the teachers in Afghanistan, however, efforts should be made by appropriate government agencies or other non-governmental organizations (NGOs) to obtain some of the most useful of these materials and translate them into Dari and Pashto languages for the benefit of the students. Eight major different perspectives are to be recognized and utilized in this context: (1) scientific; (2) historical; (3) geographic; (4) human rights; (5) gender equality; (6) values; (7) cultural diversity; (8) sustainability.

Scientific Perspective: The scientific perspective for learning about water is based upon collecting, assessing, and interpreting observational or empirical data about natural water in the parts of its hydrological cycle and the phenomena associated with these parts (Figure 1). This means that the observer reaches understandings of the changing dynamics of the water equilibriums that exist in the biologic and non-biologic components of planet Earth. This observational knowledge of water can be used to solve real-world problems. True scientific perspectives are free of context, which means that the other perspectives gained in the MPA method have no effect on the scientific water data obtained or its analysis. This perspective gained from a scientific point of view means that such knowledge gain is really the truth, or actual reality, which is therefore useful in any setting. Teaching the scientific perspective can involve any number of simple to more advanced strategies and questions by teachers to have students discover the many different aspects of water.

Figure 1A. Hydrologic cycle of the Earth showing the three different physical or chemical phases of the H2O system (liquid water, solid water ice, and gaseous water vapor), together with their transition mechanisms from one phase type to another, and the pathways by which the different phase types are transported from one place on Earth to another (from the US Geological Survey - https://water.usgs.gov/edu/graphics/watercyclesummary.jpg).

Table 6. Instructional strategies for a scientific perspective (UNESCO, 2012b). Some of these teaching methods require specialized instruments (thermometer, pH meter, pH test strips, etc.) that will not be available in Afghanistan so teachers must use alternate strategies adapted to local conditions.

- Students study diagrams of the hydrological cycle in their own language (Figure 1A)
- Students assess local water quality conditions, including such things as temperature, clearness (clarity), salty taste or not, acidity & alkalinity (pH) and other factors. Use processes of clarification, disinfection, & distillation to improve quality. Compare usefulness of procedures with students on-line elsewhere in world. See Global Water Experiment documents for methodology: http://water.chemistry2011.org/web/iyc/experiments
- Students create models of the water cycle applied to their local situation using images

or drawings to represent important processes of evaporation from surface water, transpiration from plants, condensation from the atmosphere, precipitation types, snow melting, surface water runoff, glacier water storage, and underground water flow.

Table 7. Scientific questions about water that teachers can use to educate students (UNESCO, 2012b).

1. How much variation in local water conditions do you find?
2. How can you account for such variation, or what are some factors that make such variation occur?
3. What are the stages that can be used to purify water so that you do not get sick?
4. How can you collect water scientifically so that you can study it to discover things about it?
5. Where can you get good water?
6. Where can you get bad water?
7. What is bad water?
8. What is good water for plants?
9. How can changes in weather patterns affect water availability for household (domestic) use, for irrigation, or for industry?
10. What is the significance of the different residence times (how long water stays in one form or a place) in the various phases of the water cycle?
11. What are extreme weather conditions?
12. How do extreme weather conditions in distant parts of the world affect the local weather patterns and events?
13. What is a local water catchment?
14. How can water discharge patterns in local catchment areas affect the regional catchement?
15. How does local water consumption affect regional water supplies?
16. How can thinking about the catchment system as a whole help engineers and scientists make better decisions about water management?

Historical Perspective: Using an historical perspective to learn about water helps student learners understand how natural or human-created water issues have been dealt with over long periods of time, as well as in the present day. Students should assess responses to water issues within the context of the knowledge and technology that are available to them, and according to local perceptions or cultural expectations.

Table 8. Instructional strategies for promot ing an historical perspective (UNESCO, 2012b).

- Students can create multiple-tier timelines (chronologies) of significant water events (floods, snowfalls, droughts, rainstorms, pollutions, wells drying up, etc.) over their lives, and over the past fifty years, as much as they can find out from older people who will remember.
- Students can use the multiple timelines as a starting point in order to conduct more historical research on major water events that they have heard about. Sources can include the internet, newspapers, weather records, textbooks, university scientists. They can interview community members as far back as anybody knows.
- Students can find out if people have become better able to deal with extreme water events than in the past. They can find out whether or not conditions are better or worse, and maybe they can find out why.
- Students can assess how the community at large has adapted to water extreme events, and if the adaptations were helped through technology or changes in people's practice.

Table 9. Questions about historical issues concerning water that teachers can use to educate students (UNESCO, 2012b).

1. Does any pattern of water-related events of phenomena exist that affects the quality of life?
2. Have water-management decisions in a particular water-catchment area been consistent or not over extended periods of time?
3. What have been some long-term effects of past decisions about water?
4. Has the frequency of significant water events increased, decreased, or remained about the same over the last X many years?
5. How consistent are anecdotal stories of major events from person to person, in comparison to written documents?
6. Have water management decisions in a community been consistent over a long period of time?
7. How have changes in leadership and government affected management and distribution of water supplies?
8. What effects the war has had on water supplies?

Geographic Perspective: Learning about water from a geographic perspective helps students understand how natural, and human-created water issues appear and possibly reoccur across a region, a whole country, the continent they live on, or all over the Earth. Transboundary drainage basin can be examined (Figure 2) and students can discuss who people in neighboring countries might feel about the water coming to them from Afghanistan where it first fell to Earth. Water events can occur at different scales, from small local effects, to national, and international scales. Students can study whether or not pollution can occur in just a single well or throughout a whole basin or a whole aquifer. In a similar fashion, some problem with water may appear as a pattern (for example, in agricultural valleys that use chemical pesticides or in areas with very poor sanitation or salty water). By studying the geographical scales involved and whether or not a problem keeps reoccurring, students can gain deeper insights into the origin of any particular problem and maybe they can think of possible solutions.

Figure 2. The transboundary water basins that head in Afghanistan in order of decreasing size are the Helmand, Amu Darya - Aral Sea, Kabul – Indus, Hari Rud, Murghab, and Namaksar. © 2014 Transboundary Freshwater Dispute Database; Oregon State University. Product of the Transboundary Freshwater Dispute Database, College of Earth, Ocean, and Atmospheric Sciences, Oregon State University. Additional information about the TFDD can be found at: <http://www.transboundarywaters.orst.edu>."

Table 10. Instructional strategies for promoting a geographical perspective (UNESCO, 2012b).

- Students can use copies of topographic maps to study a water event or a challenge. If maps cannot be obtained, teachers can use their imaginations to make simple planimetric maps for students to use. These maps can be used by students to outline the watershed in which they live. Then they can map the locations of where any sorts of problems exist in their region (contaminated wells, irrigation ditches, permanent or temporary rivers, war-damaged water supplies, etc.).
- Students can use different geographical methods (choropleth – color blocks; contour maps of different quantities) to map locations of different water quantities and water qualities. Many other water locations can be mapped with different map legends to explain where water things occur, and how much of any particular water type or water occurrence exists at different locations.
- Students should see if they can detect any different patterns occur in certain areas and why are things arranged spatially on the maps in certain ways (clustering or dispersed, random or regular locations, etc.).
- Students can use maps (Figure 2) to see about how water leaves Afghanistan to flow over their borders into neighboring countries.

Table 11. Questions about geography issues concerning water that teachers can use to educate students (UNESCO, 2012b).

1. Has any water-related event or challenge changed in size recently that anybody knows about?
2. Was it small previously and now it is large?
3. Is it predicted to increase in size?
4. Can you identify a pattern to a water event or to a challenge (on a ridge top more, or valley bottom)?
5. Does any nearby community have the same kinds of water problems or are they affected by similar water events or water challenges?
6. Are communities on other continents having similar water-related events or challenges?
7. How does any map that you or anyone else has made convey correctly or distort the information presented?
8. How do you think people in neighboring countries will think about any contaminated water that comes from Afghanistan?
9. What do you think will happen if Afghanistan uses up most of its own water and does not allow so much to flow over the border into neighboring countries as has always occurred in the past for as long as anyone remembers?

Human Rights Perspective: From the perspective of human rights and water, stress would be put upon the relationships between access to sufficient supplies of safe water, as well as opportunities to access other universal human rights, such as education, health, and active participation in governance by the people, especially with regard to water. Students should understand: (1) how natural distribution patterns of water may affect access to safe water; (2) how water practices may improve or worsen a group's opportunities to participate fully in other universal rights; and (3) how financial resources of individuals or communities can affect the impact of natural or human-made water issues.

Students must be taught how access to water may be affected by the natural distribution patterns of water, as well as the availability of individual human capacities and institutional capabilities, adequate governance, and financing and infrastructure. The perspective of human rights also teaches about the effects of water quantity and quality on other aspects of life's quality. Water must be considered and understood not as a purely economic good, but also as a social and cultural benefit).

Table 12. Instructional strategies from the perspective of human rights (UNESCO, 2012b).

- Students would study regional maps of their country and population (demographic) data to learn about the prevalence of water-related diseases among the poorest populations of people in the country.
- Students would come to understand that these poor places and people are related to inadequate capacities and supplies, disasters such as floods, or especially because of conflicts, resulting in intentional or unintentional destruction or disruption of the water infrastructure.
- Students would engage in discussions in which different peoples' needs and goals are represented adequately in an effort to understand all the interrelations between different human rights.

Table 13. Questions about issues of human rights concerning water that teachers can use to educate students (UNESCO, 2012b).

1. How can the quality of the water be improved to make it safe for drinking?
2. How do chronic disease and malnutrition affect a family's or a community's ability to provide a good quality of life for everyone?
3. How can the improvement of water infrastructure (wells, irrigation ditches, water treatment places), and human capacities, such as via education, improve the quality of life for all?

4. What are the implications of the human right of access to water from the perspectives of social, economic, and environmental aspects?
5. How are these implications related to other human rights, such as the right to an education?
6. Do you see how people in neighboring countries could make trouble for the people of Afghanistan if their human right to water was cut off because too many new dams were made upstream in Afghanistan to use most or all of the water inside the country instead of letting any go over the border?

Gender Equality Perspective: In the schools, students can explore how social and cultural practices may affect men and women differently with regard to access and use of drinking water and household water. This may include different gender roles in decision making at different levels about water, including water harvesting and water uses in different communities. Students can also take into consideration how access and long-standing practices related to water resources, especially for household use, may have contributed to the as-yet-unstudied consequences of traditional gender roles, including differential access to education and work opportunities. Students can also consider how advances in water-management technology (dams, wells, pipes) may have changed the local contexts for traditional, water-related gender roles, because, for example, either so much privacy or physical strength for carrying water may not be as much in some cases (Tables 14 & 15).

Table 14. Instructional strategies about water from the perspective of gender equality (UNESCO, 2012b).

- In some parts of Afghanistan women and girls have gender-specific responsibilities for getting water, which can take much time each day. Some of the problems of going to school for young girls and women in the country to become literate is because of this fact. Literacy is a key factor in establishing a good quality of life, so this factor of having to get water so much is different for boys so that equality differences can begin at an early age. Students should be taught about this and should be led to speculate on ways to make safe water more easily available to all members of the community. Ways to create more equal opportunities for education and literacy should become topics for discussion in schools to get students thinking more about such things.
- Students can undertake research about how accepted habits of providing drinking water affect the participation of different people in various aspects of community life, including school, in business and commerce, and in the governance of local and national areas.
- Students can document or write down records of the daily water-related tasks of their

own family members over several weeks of time, and then compare with records from other students to see if there are gender-related work patterns in this regard.

- Students can discuss water issues in terms of the strength required to haul water to use at home, as well as the privacy needed by women to obtain and use water in Afghanistan.

Table 15. Questions about issues of gender equality concerning water that teachers can use to educate students (UNESCO, 2012b).

1. Why might rates of poverty and illiteracy be greater among women than among men in Afghanistan?
2. How can water-related practices in Afghanistan affect people's access to education and other avenues of economic success?
3. How can water-related practices be shared more equitably among members of a community?
4. What different alternatives could exist for balancing access to water and access to education?
5. What sorts of lifestyles or societal practices does one gender practice that may decrease their ability to have equal access to resources?
6. How much flexibility exists in a particular community for people to go outside or beyond accepted gender roles?
7. Can assumptions about gender roles limit some peoples' contributions to society?
8. Are water-related practices in the community sensitive to different genders, and how?

Values Perspective: Human values about water are about how much people would like to have access to clean water, how much they would prefer to have decent sanitation for themselves and their family members n\how much they would want to protect the environment where their water comes from and keep it clean, and how much they would want to make garbage collection keep their water cleaner. Do they think that these things are important, or not so much?

Students can come to understand how particular needs or perspectives that are held by certain individuals or groups can dominate their ideas on the sustainability of water in any given area. Students can begin to recognize that participatory discussions about everyone's access to water and its usage can vary, so understandings should be sought across different sorts of value systems, with the goal of finding a consensus position or action. This can be done in the context of the well-known *loya jirga* or typical town-meeting styles of consensus building in Afghanistan.

Table 16. Instructional strategies about water from the perspective of values (UNESCO, 2012b).

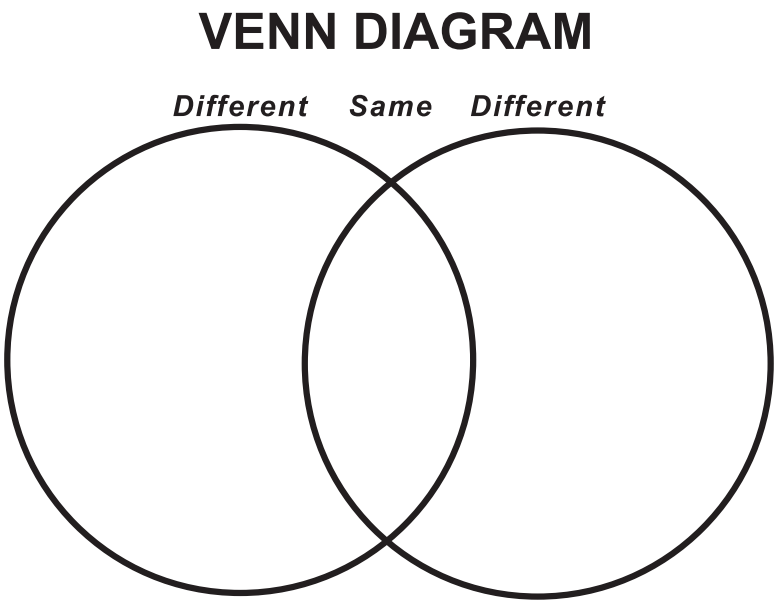
- Students should be taught a series of statements concerning water-management issues in Afghanistan. Such can be obtained in Shroder and Ahmadzai (2016). As each statement is read, students should indicate the degree to which they agree or disagree with each statement. After the students have responded on their own or independently to each of the questions, they should discuss the different opinions with each other in small groups of their fellows. Students should be guided by their teachers to explain their positions and to ask their classmates to explain why they think the way that they do.
- Students can engage in a town council or a simulated (mock) loya jirga regarding local water usage. Students can first write down the values perspective if each speaker. Then they should make Venn diagrams of overlapping circles that make connections about which values are mutually supportive (grouped together) and which seem to be mutually exclusive (grouped apart) (Figure 3).
- Students can then suggest possible solutions that acknowledge and respect the values expressed during the town council meeting, in an attempt to move toward a common course of action for everyone.

Table 17. Questions about issues of values concerning water that teachers can use to educate students (UNESCO, 2012b).

1. Did you see any sort of pattern in the responses that you obtained?
2. How would you describe your values in regard to water as a resource?
3. As you listened to you classmates explain their responses to the questions about water values, did you change your mind at all?
4. What did you learn about other people's explanations?
5. What diverse values on water are apparent in the local community?
6. What value systems are most consistent with collaborative approaches to problem solving?
7. Do the different value systems indicate a view of the world where humans are considered to be the simple consumers of the resource, or also as the caring stewards of water resources?
8. How can different value systems be respected, while still finding a single solution to the concerns about regional water supplies?

A type of teaching method known as Venn diagrams has been suggested as an excellent method to deal with studying value perspectives, although this higher order thinking can become somewhat complex for some people. Venn diagrams come from a branch of mathematics known as set theory, and are used by teachers in the simplest fashion to do rudimentary compare and contrast of processes and phenomena (Figure 3a). The teaching method can start simply with only two factors to compare in terms of similarity or difference, but move up into three or more as well.

Figure 3. Venn diagrams: 3A. Two overlapping circles showing the left and right circles, both of which would have different phenomena or processes in each of them in contrast with each other, and then the areas of overlap would have similar phenomena or processes in them; (from Emergency Management Manual Victoria, Australia, 1997; http://www.floodvictoria.vic.gov.au/centric/learn_about_flooding/flood_and_floodplain_management.jsp).



3B. Three overlapping Venn diagrams about flood management that show the three different activities in flood management (Prevention, Response, and Recovery), each of which shares certain processes with each other one where they overlap, together with a grouping in the middle where all three come together with another set of overlapping processes with all three circles (from Emergency Management Manual Victoria, Australia, 1997; http://www.floodvictoria.vic.gov.au/centric/learn_about_flooding/flood_and_floodplain_management.jsp).

Cultural Diversity Perspective: Students can come to understand that issues about water can be interpreted through different or unique views of the world that are created through practical or empirical ways of knowing, or through aesthetic or artistic understandings, or even transcendent or religious ways thinking about things. A cultural perspective is commonly a unique perspective associated with a particular ethnic community. This difference may actually separate that community from other cultural communities. A perspective of cultural diversity considers the role of water in different worldviews of different ethnic groups.

Table 18. Instructional strategies about water from the perspective of cultural diversity (UNESCO, 2012b).

- Students can understand the values attributed to water use in societies by using primary sources from several distinct cultures, such as, for example, for those where water is scarce or plentiful, or between rural and urban societies.
- Primary sources can include oral or written stories, songs, poetry, and other forms of cultural expression. Students can then compare and contrast the underlying values as expressed through the primary sources to interpret each culture's assumptions and values regarding water as a part of their worldview, or as a simple resource, and so forth.
- When combined with the historical perspective, such comparisons can also be made within a given society at different periods of time.
- Students can be given a task to consider water-related issues that embody a moral or ethical dilemma. They can then engage in a town hall-type of discussion in which different student groups take on different roles that can be based on different types of religious and/or moral arguments.

Table 19. Questions about issues of cultural diversity concerning water that teachers can use to educate students (UNESCO, 2012b).

1. What contributions of unique cultural or ethnic groups have affected water resources?
2. What cultural traditions are symbolic of the role of water in people's lives?
3. What values regarding water do customary practices convey?
4. Should economic development be permitted or pursued in areas that many people believe has a special religious significance?
5. If a mining permit is issued for an area that could harm the water, which some other people think is sacred, what are the implications for the respect of the different religious beliefs?
6. If a mining permit is denied for religious reasons, what are the implications for economic development in other areas in the country?

Sustainability Perspective: Students are asked to consider the interactions between the local ecological environments (several different ones, such as low-lying rivers or wetlands, and higher ridges and hills), and the economics of the society. They should do this within a context of long-term sustainability: will there be an adequate supply of safe water for people as well as for ecosystems now and into the future? The quality of life should be considered within the context of natural and human-made resources. Access to safe and adequate water resources to maintain life consistent with universal human rights is a requirement. The projected needs of future generations must be considered, with planning for future populations and other growth, and used as integral components of sustainability decisions.

In many parts of Afghanistan the results of looking at water resources from a perspective of sustainability is not a particularly rewarding experience because the quality of life for all too many people is already fairly minimal in many cases. This is because a number of prior studies in the country and major cities have shown numerous problems (climate change, desertification, population growth; soil erosion, environmental stress, etc; Shroder and Ahmadzai, 2016; Kakar, 2011; Shroder, 2014). Some teachers may not wish to reinforce these negative viewpoints for fear of creating more societal problems; other may choose to address the problems as much as they feel that they can safely do (Tables 20 & 21). In any case, if the minds of the students are engaged in thinking about possible strategies to find solutions to some few of these problems, the simple process of thinking and talking through the issues may help morale in the country and even reduce some of the existing urges to emigrate or run away from seemingly intractable situations that only add to the world's refugee crisis.

Table 20. Instructional strategies for learning about water through a sustainability perspective (UNESCO, 2012b).

- Students can draw a map that shows the patterns of use of the land in a local stream catchment area. Land-use patterns include residential, agricultural, industrial, and recreational.
- Students should indicate on the map how each type of land use may affect the water quality, access to the water, and distribution of the water.
- Students should next interpret how different uses of water and land can affect the overall quality of the environment, economic development, and the life quality.
- Students can begin research on raising animals and other farming practices that have the potential of minimizing non-point pollution of surface water runoff. In such a study, students should incorporate issues from economic, environmental, and societal aspects.
- Students can interview the leading farmers who might be available to learn specific

farming practices can possibly reduce costs and increase productivity.

– Students should then be given an opportunity to communicate their findings out into the community through the use of printed brochure papers, radio or television programs, or public lectures at their schools or mosques.

Table 21. Questions concerning water about issues of sustainability that teachers can use to educate students.

1. How can surface and underground water be used for economic development with minimal degradation of the ecosystem?
2. How do certain activities in one part of the catchment area affect water quality in other sections?
3. What sorts of actions can people take to maintain the quality of natural resources while at the same time developing the economic resources?
4. How can natural water purification processes be used in a connected fashion with human water-purification systems? Is this ever possible in Afghanistan in certain special areas in the country?
5. How can certain activities be most useful; such as plantings of certain beneficial plants, rain gardens, aeration ponds, and wetland, or water-basin recharge areas, and wetlands be used to supplement the natural water cycle?
6. What other sorts of structures could be used in the design of human-made areas of development, such as household residences, agricultural areas, city centers, and industrial areas to minimize degradation of water quality?
7. What different sorts of natural resources could be used to improve the economic development of the region (Shroder, 2014)?
8. What sorts of problems exist in different areas of Afghanistan that cause the most difficulties with exploiting the natural resources for the benefit of the local people?
9. What might be solutions to problems such as criminal gangs and mineral mafias in Afghanistan that slow down people from trying to solve some of these problems?

Core Recommendations on Water Education

Human and social scientists should be linked in alongside water scientists to learn and share ideas about water so that the whole society can better understand the development and use of its most precious resource. Joint courses should be developed and linked to water challenges and community water issues at all levels of education (UNESCO, 2014). The institutions of higher education in Afghanistan must best serve their society by transforming themselves to become successful examples of water management through establishment of water institutes or water centers of excellence. By coming down out of their more rarified ("ivory tower") existence in the universities and engaging with local communities about their water problems, the university administrators and their professors can more beneficially share their knowledge and ideas with local communities.

Education for sustainable development concerning water in Afghanistan should focus upon development and incorporation of sustainable values to achieve this end. This involves behavior change amongst people who generally resist modification of their unwittingly harmful practices, mostly through ignorance, but also because they have no other choices in their sorely stressed lives. Accordingly water education should not only include scientific knowledge about their water, but also a greater awareness of how other people interact both positively and negatively with the resource. Everyday more sustainable water practices can be introduced in the schools and public meetings, such as turning off well taps when not in use, harvesting rainwater off roofs, reducing wasteful flood irrigation and converting to parsimonious drip systems, forming new infiltration basins to catch more spring meltwater or summer flashfloods, thus thereby increasing ground-water recharge, and so forth.

The role of water in health, sanitation, and disease needs to be carefully included into water education programs so that teaching these topics will enable students to avoid potential health problems. The many different means to purify water must not only be taught in the schools, but potable water must be made available there as well so that students can relate such practices to their own homes. If the students have at least one place in their lives where they can go to avoid their own domestic problems with water, great advantages to going to school would only increase and help society.

Education of elementary and secondary teachers about water would greater increase teacher capacity in highly beneficial ways. Training courses, workshops, and exchange of ideas about water with other educational professionals in Afghanistan would be critical to education for sustainable development. In addition, each school should have one or two "pedagogical directors" responsible for disseminating information about water to the other teachers (UNESCO, 2014). This mechanism can help ensure a more widespread delivery of appropriate

information to increase educational capacity. A new culture of innovation and integration about water is required in the schools. Water education needs to become more interdisciplinary, holistic, and value enhancing to promote significant systemic changes in the schools and thus out into society. This can be achieved through production of more diverse stimuli to students (visual, auditory, sensorial, etc.), whereby water topics are brought into discussions in more ways through having different teachers present different ideas, different water problems, small outside field trips, and so forth.

The teaching about water should be given a local context in terms of sources, delivery systems, uses, disposal, and so forth, whenever possible. This contextualization of water to local situations is a much more efficient education methodology known as *situated learning* wherein students can relate more easily to what is being taught. Ideas of water sustainability need to be brought in repeatedly to discussions so that water conservation and reducing water pollution become strong cultural values begun at the most elemental levels of childhood education.

Education about water for sustainable development needs to developed at higher levels for water technicians, decision makers, community officials, and mass-media professionals so that essential information on water gets out into the society more efficiently. These people are the integral water management of any society, so their own knowledge must be well developed so that they can transmit correct information to the public. Ideas of water sustainability must be transmitted even in the face of seemingly intractable climate change and other hindrances to societal sustainability. The increasingly important mass media in Afghanistan will be vital to transmit good notions out to a wide variety of people. Delivery of notions of all the good things that government is doing to help in the water situations faced by the country will help greatly.

Many different water purification methods and devices have been developed in recent years that can be taught about, even if some of them (e.g. the *Lifestraw* filter) in the West may be too expensive for widespread use in Afghanistan. Still, the technical knowledge about water is most precious and needs to be democratized and disseminated to the general public in simplified and more general fashions so that the Afghan society as a whole becomes wiser about its water. People need to be given simple tools of understanding the sciences of water so that they can develop their own means of access to clean water. All villages should develop water committees beyond what they already have, even to include input from women's groups, which is most definitely not a common occurrence in Afghanistan. Finally, although Dari and Pushto are the official languages of the country of Afghanistan, efforts can be made to transmit information about water to the widest possible audiences by disseminating knowledge of water in some minority languages, and especially by clever development of sign languages and cartoon presentations on posters for the many illiterate people who exist throughout the country.

Conclusion

Water is not only totally critical too all life, but also as a material from which to gain knowledge. Just think, water is not only foremost in our personal hygiene and health habits, but it also carries the potential for curing us of some of our aliments, while it also carries disease and harmful pathogens that can kill us. Water is directly fundamental in attending to our biological needs, both by being used as a major component of our human bodies, and indirectly as a primary participant in the production of food through livestock and agriculture. The material is a substance that plays a fundamental role in life in being used extensively for production of energy, in transportation in many places, and in industry. Water has remarkable physical properties in its solid, liquid, and gaseous vapor forms, with different chemical structures in each that need to be studied in detail and understood scientifically. Water can generate electrical power, even while it is also a source of political power, as well as holding mythical, spiritual, and religious meanings as it is a source of inspiration for the arts. In fact, all human wellbeing is linked closely into environmentally and culturally significant hydrologic systems that are used intensively, but also which can be abused by pollution or overuse (UNESCO, 2014).

Recommendations for improving water education in Afghanistan are numerous and complexly overlapping, as befits the many efforts by governmental and NGOs in Afghanistan who have sought for many decades to improve the water situation in the country. Education about water at all school levels in the country is the most powerful tool to generate the changes necessary to allow the country to progress into the future. Water plays the critical role in eradication of poverty, greater equality between the genders, food security, and preservation of critical ecosystems. In the face of already existing water scarcity in the country (Shroder, 2014; Shroder and Ahmadzai, 2016) and increasing climate change that will further reduce supplies, political problems and bellicosity between water-short factions can only increase to the great detriment of the country. Guiding the future of water education in Afghanistan is thus seen as one of the most pressing needs in the nation, because a future without water cognizance will only be an ever more hopeless task. To these ends for helping the water situation in Afghanistan by improving understanding or increasing hydro-cognizance, a series of recommendations concerning water in Afghanistan have been developed (Table 22), which could be implemented in the country, but which also need to be considered within a context of improving general education on water throughout the region of Afghanistan and its neighbors. Only in this fashion can a better future be envisioned for the country.

Table 22. Recommendations about water in Afghanistan that can be incorporated into the educational system. This list was developed by the authors in consultation with the Duran Research & Analysis organization for use in a grant application that ultimately was given only to Duran, but the ideas remain germane in any case.

1. **Write a national economic development vision.** A national-level and cohesive cross-sectional economic vision for the nation that emphasizes water is required.

2. **Prioritize the national water sector.** Writing a national-level and cohesive cross-sectional economic vision for the nation will help emphasize water in the country as the region prepares for problems and shortages in the water sector.

3. **Help clarify roles and improve coordination**. Uncoordinated and confused at present, water issues need to be systemized and coordinated through a strengthening of the new Supreme Council on Water Affairs in Afghanistan.

4. **Help establish and strengthen knowledge base on water-resource development and management**. The new Water Sector Strategy (IRA, 2013) emphasizes the needs for merging scientific theory with empirical and practical knowledge on water. Such can be developed through use of Distance Learning Modules about water in Afghanistan as discussed in Shroder and Ahmadzai (2016).

5. **Write text on how to address water within the broader context**. Climate changes produce floods, droughts, and landslides that are already adversely affecting Afghans lives with drastic consequences so development and management of water resources needs special attention and proper education about such processes, which can be developed through use and adaptation of ideas from Shroder (2014) and Shroder and Ahmadzai (2016).

6. **Help improve mechanisms for national water governance.** Existing legal and policy contexts do not address development and management of transboundary water resources, with the result that a new adaptive and integrated management plan must focus on transboundary water issues.

7. **Help Afghanistan to recognize the benefit of regional cooperation, hydro-diplomacy, and compliance with international conventions.** Regional cooperation is absolutely essential to any effective management and development of water resources, with the result that work must be done with diverse regional entities to enable cross-border educational dialogues about water.

8. **Work out rationales and procedures to promote a long-term, regional-program**

approach. International support and investment are required in coming years because they are critical elements of future stability in the region so these issues must be discussed with appropriate funding agencies to ensure progress.

9. **Use the media and possible new web portals to engage civil society, media, academia, and the private sector.** Hydro-cognizant capacity building for wide sectors of Afghan society is a starting point to provide a wide-enough support for these sectors, as well as in neighboring countries to help ensure some success about water in future in Afghanistan.

10. **Help advocate for increased engagement** of civil society, media, academia, and the private sector in water development and management through media efforts.

11. **Help support and facilitate continuous indigenous Afghan research** on all water issues through electronic media.

12. **Help advocate for improved legal and policy contexts** of transboundary water resources by enlisting the assistance of legal scholars on world water law.

13. **Help expand Afghanistan's knowledge base** on transboundary water resources through translations of the book on Transboundary Water Resources of Afghanistan by Shroder and Ahmadzai (2016) for modification and distribution into the educational milieu of Afghanistan.

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Transboundary Cooperation

Water as a Unifying Factor

Dr. Glen Hearns

Two parts hydrogen, one part oxygen, but there is a third thing that makes up water and nobody knows what that is.

D.H. Lawrence

Water as a Unique Molecule

Water is special. It is not like any other substance we know of. Indeed, life on Earth, as we have come to understand it, would not exist without the presence of water. While many organisms can survive without oxygen gas (O_2), there is no self-reproducing entity that exists without the presence of water. This single aspect of water profoundly separates it in our human psyche from other resources and materials. It is also an overpoweringly mysterious and curious substance.

Under normal conditions, "standard temperature and pressure" in science terminology, we know it as a liquid but based on its molecular weight and density measurements it should be a gas. As is the case with the very similar compound hydrogen sulphide (H_2S) which is almost twice as dense as water (H_2O) (Nuffield, 2000). A strange anomaly exists in water called "hydrogen bonding" which pulls the hydrogen atom towards the oxygen molecule together so intensely that is a liquid under normal conditions. Its sister molecule hydrogen sulphide also experiences hydrogen bonding although not as intensely and, hence, we know it as a gas.

Water is the only known substance to exist naturally and abundantly on the Earth's surface in all three states: gaseous (vapour and clouds), liquid (rivers and lakes) and solid (ice and snow). Moreover, it can exist in all three states together, for example when the snow and glaciers melt in the mountains and there is moisture in the air.

Because of its unique molecular structure and intense hydrogen bonding the solid form of water, ice, has an open hexagonal lattice structure. The result is the surprising phenomena that density of ice is less than the density of water at the same temperature; thus, the solid phase of water floats on the liquid, unlike most other substances we know. This allows for polar ice-caps and provides migration routes to animals across large rivers and lakes However, it also ensures that lakes maintain liquid water under the ice as ice provides insulation to the water below. While there are several other substances that exhibit this property, water is the only non-metal compound to do so (Nuffield, 2000).

When looking at its thermodynamic properties, water is again an oddity. Compared to other similar compounds, H_2O has a very high boiling point, melting point, and viscosity compared to otherwise similar liquids not conjoined by hydrogen bonds. Furthermore, the absolute difference between these points (0 to 100°C) means that water has a very large temperature range in which it remains a liquid. It also has an uncharacteristically high specific heat capacity, making it a good heat storage medium (Nuffield, 1984). Many people are aware of the moderating influence that oceans and large lakes have on temperature in surrounding areas. However, it is less appreciated that water vapour in the atmosphere assists the trapping of solar radiation making the average temperature at the Earth's surface a comfortable 15°C, instead of a chilly -18°C if no water vapour existed.

Its chemical attributes give rise to equally strange effects. Because of its structure, water exhibits polar qualities such that the part with the oxygen atom is strongly negative while the part with the hydrogen atoms is positive. Furthermore, it is amphoteric, meaning that is able to act as either an acid or a base depending on its surrounding environment (Nuffield, 2000). These qualities make water the most powerful and versatile natural solvent allowing for many types of materials to be transported or dissolved.

Also because of its unique properties it is used in industry for processing, heat transport, as a solvent, and assimilator of pollution. It is essential to grow plants and thus is the basis of our food, and critical for irrigation (Smil, 2001). Domestically, water is used for washing, in food preparation, and of course for drinking. The final and perhaps most important aspect of water, from a human utilitarian perspective, is that in most of its uses water has no substitutes (Wolf, 1997). Consequently, the economic theories depending upon 'substitution' as part of economic valuation will never adequately address issues of water pricing or use. Indeed, the International Law Commission[42] determined that while groundwater in confined aquifers and oil and gas have many similarities the legal principles governing their equitable and reasonable use cannot be interchanged due to the 'vital nature' of water (ILC, 2008).

Hydrological Cycle

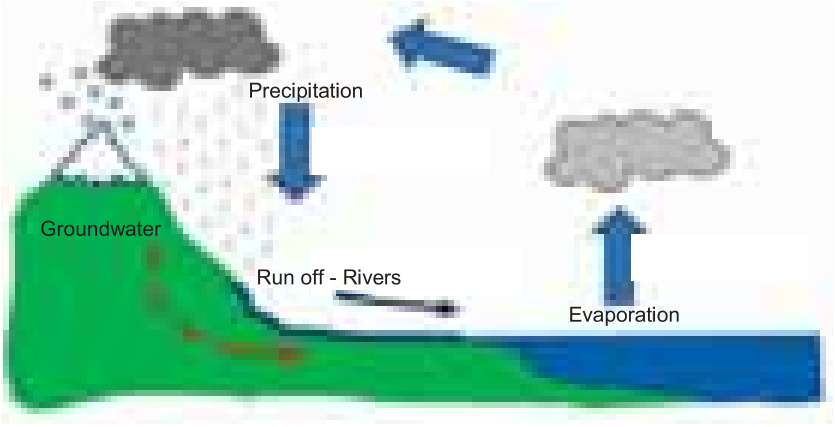
Water is the most abundant molecule on the Earth's surface (Nuffield, 2000). And its unique properties have given rise to the hydrological cycle, the continuous exchange of water between the atmosphere, soils, plants, surface and ground water, and oceans. In summary, water evaporates from water bodies (mostly in the oceans because of their relative surface area), is transported through the atmosphere, cooled and falls as rain or snow (Figure 1). If this occurs overland masses, the water moves through soil, groundwater, lakes and rivers back to the oceans or endorheic basins, such as the Caspian Sea.[43] For example, the bulk of the precipitation that occurs in winter over the Hindu Kush mountains in Afghanistan originates from the Mediterranean Sea and eventually either reaches the ocean through the Indus Basin, or inland areas such as the Aral Sea or the Hamouns of the Sistan. There it will evaporate to continue the cycle.

[42] The International Law Commission was formed in 1948 and is the primary body responsible for developing international law for the United Nations.

[43] Some rivers do not end in oceans but rather in endorheic lakes or large inland seas such as the Aral and Caspian seas. Also, many lakes are so large that they have a great deal of evaporation which influences the climate. For example the Great Lakes of North America and the Central Lakes of Africa. Some man-made structures also influence

During its stage on the surface or underground, water dissolves gases and minerals, and transports nutrients and sediment. Some surface water will evaporate, and while in the soil some is taken up by plants and returned to the atmosphere through transpiration. In general groundwater moves, so even though water may be withdrawn from a river for irrigation some water will return to the river via groundwater, some will remain longer in the soils and as groundwater that does not feed the river, and some will return to the air as water vapour through transpiration from plants. This cycle makes water renewable in that in a given part of the cycle it will continue to be replenished; however, it is also finite in that there is limited amount for us to share with each other and with the environment upon which we depend.

Figure 1: Cycle of Water Movement



Its features of being vital for survival, highly mobile and finite gives rise to the special way that we approach managing water as a resource particularly when it is shared with other groups. For example, in 2000 the International Law Commission[44] decided to include 'shared natural resources of states' in its long-term program of work (ILC, 2005). Initially, the group was to look at oil and gas as well as groundwater; however, as a priority they decided first to explore groundwater issues. The 3rd Report on Shared Natural Resources forwarded several principles which mirrored those of the UN Watercourses Convention in 1997, with differences based on renewable and non-renewable groundwater pertaining to recharged and non-recharged aquifers

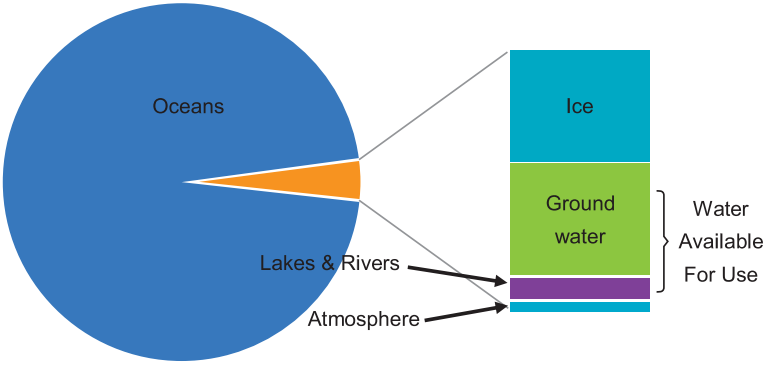
[44] The International Law Commission is the primary body of the United Nations which deals with the development of new international law. It was formed in 1948.

(ILC, 2005). Most importantly, it explicitly noted that many of the principles being developed to deal with groundwater cannot be translated to oil and gas due to the 'vital nature' of water (ILC, 2005).

What do we Need and where is it Found?

With water so essential to life it is fortunate that it is the most abundant molecule on the Earth's surface. Unfortunately, the amount available for human consumption is relatively small. It has been estimated that the volume of the water on Earth is 1.38 billion km^3, of which 96.5 % lies in the oceans, 1.75% is solid in the form of ice caps and glaciers, 1.7% is groundwater, only 0.007% is in fresh water lakes and rivers, and tiny fraction is in the atmosphere (Gleick, 1996; UN-WWP, 2003). As there is no way to entirely access all the water in soils and groundwater,[45] less than 1% of the water on Earth is available for us to use for human consumption and to share with terrestrial plants and animals (Figure 2).

Figure 2: Global Abundance of Water (UN-WWP, 2003)



Fortunately, we do not need a lot of fresh water to survive. To keep us alive we need about 5 litres per person each day (5 l/c/d), and for hygiene and domestic use we need a minimum of an additional 15 l/c/d (Davis & Lambert, 2002). However, we tend to use a good deal more than this "minimum" for our domestic uses. On our domestic use varies widely around the globe and within countries. Not surprisingly, some of the most efficient users are in water scarce areas, such as Mexico and Australia (urban areas have reached efficiencies of 80

[45] 1/2 is in capillaries and associated with surface tension of particles in rock formations.

l/c/d), although other countries such as Germany with a temperate climate are also efficient. Water rich countries have much to learn in terms of water savings, for example Canada's domestic use in the range of 350 l/c/d. Unfortunately, domestic water use in many water scarce regions of the world is not necessarily low. For example, in Iran's second largest city Mashaad in the arid north east of the country the domestic water use is estimated at approximately 230 l/cap/day in the city,[46] while in the rural areas of Iran's Fars province domestic water consumption was around 120 L/cap/day (Keshavarzia et al., 2006). Domestic and municipal use do not make up the bulk of a country's water use (Table 1).

Industry and manufacturing, particularly mining can be a large user of water. And, in more industrialized economies of Europe this can account for as much as 40% of water abstractions (Forseter, 2014). In Afghanistan by, comparison it makes up approximately 1% of water abstractions (Table 1).

The largest water use, however, is agriculture which accounts for 92% of water use globally (Hoekstra & Mekonnen, 2011). It has been estimated that in Afghanistan 98% of water use is in agriculture (Table 1). Great advances are being made with respect to water conservation, particularly for irrigation through better conveyance and at on farm application. However, more advances are needed to help areas like the Jordan valley ensure the maximum benefits from water use.

Table 1 Water Use by Sector in Central Asia[47]

Country	Agriculture/food	Municipalities	Industry
Afghanistan	98	1	1
Iran	92	6.7	1.3
Kazakhstan	66	4	30
Pakistan	94	5	1
Tajikistan	90	6	4
Turkmenistan	94	2.7	3
Uzbekistan	90	3	7

[46] http://news.mashhad.ir/index.php?module=cdk&func=loadmodule&system=cdk&sismodule=user/content_view.php&cnt_id=48380&ctp_id=2&id=3514&sisOp=view

[47] See FAO AquaStat at http://www.fao.org/nr/water/aquastat/water_use/index.stm.

Even though less than 1% of the Earth's water is available to us to use, there is enough to satisfy our uses and share with the environment. The problem however, is that groundwater and surface-water are not distributed evenly throughout the globe, and, ironically, the areas where water is most needed are generally the areas where it is least abundant (Brooks, 1997). Consider the water abundant areas of northern Canada or Eurasia, such as the Mackenzie River basin with an estimated annual flow of 300 bcm/year[48] and a population of less than Kabul. Another example is the astounding fact that some 20% of our fresh surface-water is found within a single lake in Russia: Lake Baikal (Schklomanov & Rodda, 2003). In contrast, countries such as Egypt, Jordan, Israel and others in the Middle East Northern African (MENA) region reached a situation in the late 1990s when their water needs exceeded their actual water budgets (Allen, 2001). Many of these countries have moved into a scenario where to survive they use their water in high value enterprises such as industry or high value crops for export, like flowers, and then purchase water intensive commodities such as wheat from water rich countries like Argentina.

Water: Point of Conflict or Cooperation?

With water not always being where it is needed it is not surprising that water has been seen throughout history as potential point of conflict. It is perhaps illuminating to note, that the English word 'rival', meaning 'one who is another's competitor,' is derived from the Latin *rivalis*, meaning 'one using the same stream as another.'[49] Despite this engrained terminology, water has also been a focal point for cooperation.

A case of conflict: in late July 2006, the Tamil Tigers (Liberation Tigers of Tamil Eelam (LTTE)) halted the flow of water to the government-held Muslim town of Mutur, in Triconomalee Bay in the North Eastern Province of Sri Lanka. By controlling a sluice to the south of the city, the Tigers were able to cut off water supply to over 50,000 residents in the town. The government forces responded by bombarding the area, and the heaviest fighting erupted between the two sides since the signing of the cease-fire agreement in 2002. The town of Mutur was severely damaged by shells, from both government and Tiger sources, access to water was ruined, and the livelihoods of many destroyed. (Apps, 2006a, 2006b, 2006c).

[48] This is 5 times the flow of the entire Amu Darya.

[49] The word rival has its origins in the 16th Century and is related to 'river' or 'rio' in Spanish. It is derived from the Latin *rivalis* and means 'one who shares a stream with another'. See Corominas, Joan, 1987 Breve Diccionario Etimológico de la Lengua Castellana, Editoral Gerdos, Mardid, page 510.

A case of cooperation: in 1993, while a civil war threatened to destabilise the then newly independent Georgia, an agreement was reached between the government and Abkhazian separatists regarding the operations of a hydroelectric power station (Garb & Whiteley, 2001). The hydroelectric station spanned the Inguri River, which creates the border between Georgia and Abkhazia, now an autonomous republic within Georgia (BBC Monitoring, 2006). Both areas depended heavily on the electricity generated by the plant, and neither could operate nor run the plant without the help of the other. Although no peace settlement was in sight, the two authorities managed to agree on a joint management system and joint financing for the plant (Garb & Whiteley, 2001).

A case of cooperation: in 1994, despite having been at war and previously not acknowledging the existence of Israel, Jordan signed a Peace Agreement in which Annex II is devoted to sharing water in the Jordan River Valley.[50] Despite previous severe hostilities between the two countries they were able to come to an agreement whereby, amongst other things, Israel receives 25 mcm/yr of water from Jordan, and also agrees to store winter flows on behalf of Jordan in Israel to return to Jordan in the summer when it is most needed (Article 1). Additionally, Jordan allows Israel to continue to use groundwater wells on Jordanian territory (Article 4). The water issues are addressed through a joint water committee which oversees water cooperation between the two countries (Article 7). Annex II of the 1994 Peace Treaty clearly attempts address essential water resources issues with practical solutions ultimately beneficial to both populations dependent on the resource.

The view that water is a catalyst of cooperation has strong support, as indicated by the burgeoning number of transboundary agreements and acts of cooperation[51] (Hamner & Wolf, 1998; Swain, 2001; Wolf, Stahl, & Macomber., 2003; Yoffe, Wolf, & Giordano, 2003). Aaron Wolf and his group at the Department of Geosciences, Oregon State University, created the Transboundary Freshwater Dispute Database (TFDD, 2013) to run large-scale statistical studies regarding transboundary freshwater. Using a data-base with over 1800 entries that spans more than a century their results suggest that water-related acts of cooperation, such as treaty development, outweigh water related acts of aggression and conflict (Beach et al., 2000; Wolf, 1997). Some 85% of water treaties that they surveyed dealt with either hydro-power and water supply, or both (Hamner & Wolf, 1998).

[50] Treaty of Peace between the State of Israel and the Hashemite Kingdom of Jordan, Signed at Arava/Araba Crossing Point on October 26 1994. Annex II Water Related Matters.

[51] Acts of cooperation can also be public political statements or support or intent, exchanging information, conducting joint studies etc.

The simple existence of treaties is silent on whether the treaty is equitable or whether or not there is commitment to its enforcement. Africa now has some 150 water agreements, accounting for some 25% of all the global total; however, the number greatly overstates the degree to which transboundary cooperation is occurring (Lautze & Giordano, 2005). To illustrate, powerful states such as Nigeria, Egypt[52] and South Africa are involved in over 50% of Africa's water agreements and the latter two nations overwhelmingly favour bilateral over multi-lateral agreements (Lautze & Giordano, 2005).

While acknowledging, the limitations concerning large-scale statistical studies, two findings from Wolf's work are of particular significance to addressing transboundary water issues:

- Firstly, extremes of both cooperation and aggression over water are seen in marginalised climates, for example arid and semi-arid regions (Wolf et al., 2003). This shows that neither conflict nor cooperation are determined by factors such as water scarcity but, rather, are exacerbated by it.
- Secondly, tension is created when processes of change exceed the ability of institutions to mitigate that change (Yoffe et al., 2003). Prominent processes of change include changes to water quality, due to pollution, and altered hydraulic regimes through: climate variability, creation of dams, and large-scale extractions, amongst others.

This suggests that the effectiveness of institutional arrangements will determine whether a basin falls into conflict or rises to cooperation in times of water stress. The importance of institutional development as a key-stone to successful transboundary water management is supported by numerous authorities in the field of transboundary waters (Bernauer, 2002; Elhance, 2000; Hearns, Taylor, & Paisley, 2014; Jaspers, 2003; Marty, 2001; Nakayama, 1997; Wouters, 2002).

Cooperation can be viewed as the mirror of conflict. There is a range of cooperation that can exist that can move from exchanging information, to coordination, to collaboration, to joint development (Sadoff & Grey, 2002). There is however, an important distinction between what I call "passive" and "active" cooperation. "Passive" cooperation is at the low effort end of the cooperation spectrum. In some cases, it is little more than an absence, or minimizing, of conflict.

[52] In Egypt's case this includes bilateral treaties with upstream states with whom they share no border. In 1949 Egypt agreed to compensate Uganda for loss of hydroelectric power at the Owen Falls Dam so that the dam could operate to benefit flows in the lower Nile for irrigation purposes. See The Exchange of Notes constituting an Agreement between UK and Egypt regarding the Construction of the Owen Falls Dam, 30 and 31 May 1949, Legislative Texts, Treaty no. 9. Cited in McCaffrey (2001).

"Active" cooperation involves mutual interaction and interdependency. Indeed, meeting future challenges of transboundary water management will involve high levels of interdependence between states sharing those resources. While cooperation between states has a history as old as the formation of the nation state itself, the level of state interdependence needed is not necessarily easy to achieve. Although cooperation is one of the fundamental principles of international law (Higgins, 1994; Malanczuck, 1997), the concept of state cooperation may be described to be evolving as issues demanding cooperation become increasingly complex and inter-jurisdictional in nature. It is best defined by the UN Declaration on Friendly Relations[53] and involves concepts such as: refraining from using force to settle disputes by peaceful means; the duty not to intervene in the domestic affairs of other states; and working collaboratively to maintain international peace and security and promote economic stability and progress, amongst others. *Active cooperation* is therefore the situation where shared resources are managed in a sustainable and effective way to maximize benefits of the resource.

Over 30 years ago, Martin Hoffmann suggested that cooperation is a common evolutionary trait, emerging from altruism as an inherent part of human nature (Hoffmann, 1978). Many theorists at the time suggested that egoism and selfishness were dominant and that sensitivity and compassion needed to be 'trained' or 'taught' (Dawkins, 1976). However, Hoffmann showed that empathy, and, thus, compassion, were innate and needed only to be fostered to flourish (Hoffmann, 1978). 'Inclusive fitness' is a key concept of modern evolutionary biology dictating that humans are programmed not only to be egoistic but also, under certain conditions, to help another at cost to themselves (Hoffmann, 1978):

> *There appears to be a general human tendency to help others in distress, which has properties analogous to egoistic motivation and yet comes into play independently of egoistic motivation. Empathy is reliably aroused in humans in response to misfortune in others, predisposing the individual toward helping action and yet is amenable to perceptual and cognitive control* (Hoffmann, 1978).

Although, caution should be used in extrapolating individual human behavior to the level of the state, Hoffmann's work illustrates the importance of fostering and promoting cooperation in a general sense as well as at the international level.

While altruism is the action of incurring costs by one actor for the benefit of another, cooperation is incurring mutual costs for mutual benefit. The concept that cooperation emerges from altruism at a cost to each actor implies, therefore, that participatory and functional

[53] See the definition of cooperation from Resolution 2625 (XXV) Declaration of the Principles of International Law concerning Friendly Relations and Co-operation among States in accordance with the Charter of the United Nations.

elements are associated with cooperation. Each actor must 'give' in order to receive benefits. Ideally, as in the case of the Inguri River Hydro-electric station, the synergistic benefits of cooperation far outweigh the costs. These elements involve a degree of interdependency between actors; it can be extreme, as the Inguri River situation exemplifies, or it can be more modest, such as flood control on the upper Rhine River between Austria and Switzerland (Marty, 2001).

Acknowledging that cooperation is more than conflict avoidance is important when developing institutional structures that can withstand the new challenges of the 21st Century. We will have to optimize by equitably, reasonably and sustainably utilizing the waters of our international basins to meet the future needs of those generations living within them (Hearns et al., 2014). These ideas are not new, and they form the basis for the principle of equitable and reasonable utilization which is arguably the cornerstone of international water law and is codified in Article 5 of the UN Watercourses Convention.[54] What will be critical is anticipating basins at risk of conflict and to promote cooperation there in a proactive manner. This by no means excludes giving attention to basins with existing agreements and institutional structures. Fundamental management components are absent from many international basins that have existing institutions frameworks and joint management structures (Giordano & Wolf, 2003). It will be important to review existing and established agreements to see if they are truly cooperative in nature to optimize water resources, or whether they simply facilitate mutual self-restraint and conflict avoidance. Many are unlikely to withstand the potential effects of population pressure and climate change (Draper and Kundell, 2007). Another key issue is that often in areas where institutions have been developed they mirror power asymmetries which exist in the basin thereby perpetuating inequity in benefits (Berardo & Gerlak, 2012).

In many parts of the world, politicians and policy makers are appreciating that water is central to realizing their development goals and aspirations for poverty alleviation (UNESCO-WWAP, 2006). The question is whether or not sufficient political will can enhance many of the current institutional arrangements in order to adapt to the new challenges of this Century.

[54] *The United Nations Convention on the Non-Navigational Uses of International Water Courses*. General Assembly Resolution 51/229 UN Doc A/RES/51/869 (May 21, 1997). 36 ILM 700 (1997)

Sharing Resources is Hard; and Cooperation is Important

Sharing resources between different user groups or across jurisdictions is tricky at the best of times; and when those jurisdictions are international boundaries it becomes even more convoluted. On the one hand states have an inherent right to use resources in their borders to meet the needs of their populations. However, other states have an equivalent right not to be adversely affected by development in another country and if the said resource is shared then they have an equivalent right to use it as well. This did not really matter too much when development was minor and our ability to harness the Earth's resources was limited. Now, however, we have reached a phase where we humans are, arguably, the largest force in nature. Indeed, some geologists are calling for a new geological era: the Anthropocene.

To deal with our increasing capabilities to influence other states when we use shared resources, the world community has evolved, over several decades, and has developed ideas and principles. Arguably, the most important and prominent is that of "cooperation". It is a well-developed principle in customary international law and forms the subject of Chapter 2 of Agenda 21 entitled, *"International cooperation to accelerate sustainable development in developing countries and related domestic policies"*. It can be viewed as one of the cornerstones of the whole of Agenda 21 and has become central to the concept of sustainable development. Moreover, cooperation in Agenda 21 is very assertive calling for a 'genuine cooperation and solidarity' to overcome the challenges of environment and development.[55] The last principle of the Rio Declaration, principle 27, solidifies good faith and partnership in cooperation:

> *States and people shall cooperate in good faith and in a spirit of partnership in the fulfillment of the principles embodied in this Declaration and in the further development of international law in the field of sustainable development.*[56]

The United Nations Convention of Environment and Development (UNCED), held in Rio de Janeiro in 1992, emphasized increased commitments for transboundary cooperation. The conference was prolific in developing agreements involving cooperation to promote sustainable development; documents such as: The Framework Convention on Climate Change, The Convention on Biological Diversity, Agenda 21, The Rio Declaration, and the Statement on Forest Principles were all promoting cooperation over the use of the Earth's natural resources.

Since the 1970s, there has been a burgeoning of international environmental laws related to shared resources in many sectors. Apart from those associated with UNCED, major

[55] See Chapter 2, Agenda 21.

[56] Rio Declaration on Environment and Development, Rio de Janeiro, 3-14 June, 1992.

developments include: Convention on Wetlands of International Importance Especially as Waterfowl Habitat (Ramsar, 1971), Convention on Migratory Species and Wild Animals (Bonn, 23 June, 1979), United Nations Law of the Sea (Montego Bay, 1982), Convention to Protect the Ozone Layer (Vienna, 1985), Protocol of the Vienna Convention (Montreal, 1987), Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (Basel, 1989), Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks (New York, 1995), the Kyoto Protocol to the United Nations Convention on Climate Change (Kyoto, 1997), and the Paris Agreement on Climate Change (Paris, 2016). Beyond these major global conventions and accords, there are a score of regional agreements promoting cooperation between states dealing with shared natural resources. Fortunately, cooperation over shared resources has become increasingly common throughout all types of resources and water is one of them. However, the approach taken with addressing water issues has evolved uniquely, quite possibly due to its unique characteristics.

Dealing with Transboundary Watercourses

On 14th of August 2014 the UN Convention on the Non-navigational Uses of International Watercourses became a global enforceable treaty with the entry of Vietnam, its 36th member. The wealth of treaty law and state practice related to international water basins generates several strong principles of customary law which have been codified in the UN Water Courses Convention (Leb, 2013; Stephan McCaffrey, 2001a; Moermond & Erickson, 1987; Teclaff, 1967). The UN Watercourses Convention was adopted in 1997 by the United Nations General Assembly by a vote of 103 for and three against,[57] with 27 abstentions and 33 members absent (Stephan McCaffrey, 2001b). The 1997 Watercourses Convention has resolved the historic dispute between the extreme principles of territorial sovereignty and that of national integrity, placing the principle of equitable and reasonable utilization as the leading principle of international law along watercourses (Browder & Ortolano, 2000; Draper, 2002; Leb, 2013; Stephan McCaffrey, 2001b). The principle is found in Article 5 of the Watercourses Convention and states:

> *Watercourse States shall in their respective territories utilize an international watercourse in an equitable and reasonable manner. In particular, an international watercourse shall be used and developed by watercourse States with a view to attaining optimal and sustainable utilization thereof and benefits therefrom, taking into account the interests of the watercourse States concerned, consistent with adequate protection of the watercourse.*

[57] China, Turkey and Burundi.

The principle of territorial sovereignty is the simplest theory, implying that states have the right to unbridled development or use of water resources within their territory irrespective of the repercussions to other states (Moermond & Erickson, 1987). This archaic view is associated with the Harmon Doctrine (J. Cohen, 1991),[58] which basically states that in the absence of established laws to the contrary, a state may proceed to exploit its water resources in any way it deems appropriate, and that jurisdiction within its territory is exclusive and absolute. The idea that upper riparian states have no responsibility to lower riparian states is generally considered as unjust and has been abandoned (Chenevert, 1992).

The principle of territorial or national integrity is a mirroring of the sovereignty principle, implying that lower riparian states have the right to receive the continuous natural flow of an international watercourse undiminished in quantity and unaltered in quality. Such an approach places a virtual veto in the hands of the lower riparian state with respect to the development of water resources in the upstream state and has also been rejected (Wouters, 1996, 1997). Early in the century, there was a growing move towards the principle of prior consent for riparian developments. This movement was supported by a number of influential institutes and conferences, such as the 1911 Madrid Declaration of the Institute of International Law; the 1933 Declaration of Montevideo by the Seventh International Conference of American States; and the 1957 Buenos Aires Resolution of the 10th Conference of the Inter-American Bar Association (Wouters, 1997). The declarations and statements from these supported the idea that consent of co-riparian states is required by customary international law before a state may lawfully make use of waters in its rivers.

The most famous rejection involving the principle of prior consent came from the arbitration of Lake Lanoux (1957), when Spain formally objected to a French proposal to develop hydroelectric power on Lake Lanoux and the river Carol (which runs into Spain). Under the Treaty of Bayonne (1866), France had assured Spain the right of natural flow of the river Carol. Spain felt that the construction of a hydroelectric project would be in breach of the Treaty of Bayonne and further claimed that customary international law required France to negotiate an agreement with Spain before effectuating its hydroelectric plan. Spain further argued that international law sanctions not only the equality of rights of co-riparian states but also the

[58] (J. Cohen, 1991). "In 1895 Mexico protested to the US the diversion of the Rio Grande to the detriment of existing Mexican uses. It claimed that its inhabitants had established the right to use the river's waters for hundreds of years prior to the time that the settlers in Colorado began to use them. Notwithstanding, Attorney General Harmon declared that "the rules, principles, and precedents of international law impose no liability or obligations upon the US" to share the water with Mexico or to pay damages for injury caused by the diversion." See also Weston, Burns; Richard Falk & Anthony D'Amato, International Law and World Order, 2nd. Edition, West Publishing Co., 1990.

necessity of prior agreement whenever a substantial alteration of a transboundary system of waters is contemplated (Teclaff, 1967).

The Tribunal arbitrating the Lake Lanoux[59] case concluded: "The rule that States may utilise the hydraulic power of international watercourses only on the condition of a prior agreement between interested States cannot be established as a custom, even less as a general principle of law." It continued by stating:

> *As a matter of form, the upstream State has, procedurally, a right of initiative; it is not obliged to associate the downstream State in the elaboration of its schemes. If, in the course of discussions, the downstream State submits schemes to it, the upstream State must examine them, but it has the right to give preference to the solution contained in its own scheme provided that it takes into consideration in a reasonable manner the interests of the downstream State* (Weston et al., 1990).

Emerging to balance unbridled development from the 'right of initiative' was the principle of 'no harm,' which has been adopted by numerous environmental treaties and conventions. In its simplest form, the "no harm" principle which states that the development actions of one state should not negatively affect another state. In the realm of environmental law this has sometimes been interpreted in an absolute manner such that "no harm" can be done for example with pollution. However, international water law has evolved to look at "no harm" not as an absolute, but rather as a "procedural due diligence". Article 7 of the 1997 Watercourses Convention states: "Watercourse States shall, in utilizing an international watercourse in their territories, take all appropriate measures to prevent the causing of significant harm to other watercourse States." This means that appropriate actions should be taken to avoid the harm, for example prior notification, cooperation and communication. It acknowledges that there may be situations where harm, even significant, might occur but that still might be equitable and reasonable based on the unique context of any particular basin. All actions should be taken to avoid it. That is simply part of being a good neighborliness.

The principle of equitable and reasonable utilization emerged to balance the 'right of initiative' with the principle of 'no harm.' Several key decisions conducted by the Supreme Court of the United States regarding inter-state conflicts over water use have been instrumental in solidifying the principle as the corner-stone of transboundary water law (Stephan McCaffrey, 2001b). The principle first took its present form in the Helsinki Rules on the Use of Waters of

[59] Lake Lanoux Arbitration (France v. Spain), 24 I.L.R 101, 127-130, 140 (1957), 12 U.N.R.I.A.A. 281, 306-308, 316 (1964). See (Weston, Falk, & D'Amato, 1990).

International Rivers, adopted by the International Law Association in 1966 (Leb, 2013). Numerous other legal mechanisms, such as the Stockholm Declaration (1972), and the Charter of Economic Rights and Duties of States (1975), amongst others, have all influenced the atmosphere in which this principle evolved. This mood is particularly evident in the preamble to the Watercourses Convention suggesting that it be interpreted by recalling the principles and recommendations adopted by United Nations Convention on Economic Development in the Rio Declaration and Agenda 21 (1992).[60] Moreover, use of the principle of equitable and reasonable utilization in decision making and arbitrations, such as the International Court of Justice ruling on the Gabčikovo-Nagymaros Project[61] and Pulp Mill Case[62] has further solidified its prominence.

The principle, however, has not remained static. Wording in the Helsinki Rules (1966) calls for an 'equitable and reasonable share' of waters, while the Watercourses Convention calls for use in an 'equitable and reasonable manner' implying that there are many more considerations to be taken than simply quantity or appropriation. It should come as no surprise that legal concepts evolve alongside scientific understanding and knowledge (Leb, 2013). As previously mentioned, transboundary environmental issues are forcing the evolution of the concept of national sovereignty (Barkin & Shambaugh, 1999; Matthew, 1999). With reduced available resources and increased uncertainty, we will likely see an increased evolution of the importance of 'optimal and sustainable' alongside 'equitable and reasonable' use.

In legal literature, there has been great debate over apparent conflicts between the principles of 'no harm,' as written in Article 7, and 'equitable and reasonable utilization,' as written in Article 5 of the Convention (Dellapenna, 1996; Guruswamy, Palmer, Weston, & Carlson, 1999; Stephen McCaffrey, 1996; Schroeder-Wildberg, 2002; Utton, 1996; Wouters, 1996). In terms of whether the 'principle of equitable and reasonable utilization' or the 'principle of no significant harm' should prevail, most authors favor the former. As Wouters points out, it is unlikely that states will embrace a dominant 'no significant harm' approach to watercourse development as it appears to many to be too limiting (Wouters, 1996). It has been argued that the primacy of equitable and reasonable utilization from the simple position that any

[60] Principle 2 of the Rio Declaration is identical to principle 21 of the Stockholm Declaration made 20 years previously as states that: "States have, in accordance with the Charter of the United Nations and the principles of international law, the sovereign right to exploit their own resources pursuant to their own environmental and developmental policies, and the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction."

[61] Gabčikovo-Nagymaros Project (Hungry vs Slovakia) 1997 ICJ Rep.7.

[62] Pulp Mill Case (Uruguay vs. Argentina) – in 2004 and again in 2007 Argentina took Uruguay to the International Court of Justice for building a pulp mill on the Uruguay River.

development or utilization of a watercourse by a state causing significant harm to a co-riparian state cannot be considered as reasonable (Dellapenna, 1996). Unanswered questions, however, are the determination of 'reasonable' and 'significant.' There is no absolute standard; while some uses may generally be considered reasonable or unreasonable, or some effects significant or not, there is a great deal of grey area between the two extremes.

It can be argued that the principle 'of equitable and reasonable utilization' should not be taken out of context, and that its context is with the supporting rights and obligations of the Watercourses Convention. For example, Article 8, the obligation to cooperate, promotes a basin wide approach to dealing with watercourse development and, therefore, a more holistic view of water resources development.[63]

The concept of cooperation for mutual benefit and good faith again implies that there is an acknowledgement of co-riparian interests when developing water resources. Utilization could only be considered effectively equitable and reasonable if co-riparian interests are considered in the development of watercourses. Furthermore, the idea of obtaining optimal utilization suggests complimentary activities, benefit sharing and, therefore, a degree of interdependency between actors.

The lack of ratifying instruments for the Watercourses Convention prohibits the argument that all its provisions should be binding or form part of customary law. Nevertheless, its overwhelming adoption by the General Assembly reinforces the application of the principles of equitable and reasonable utilization, no significant harm, prior consultation, and duty to cooperate, as customary international law.

There remains, however, the question of determining 'equitable and reasonable.' Article 6 of the Watercourses Convention gives guidance as to 'how' to determine what is equitable and reasonable, as follows:

1. *Utilization of an international watercourse in an equitable and reasonable manner within the meaning of article 5 requires taking into account all relevant factors and circumstances, including:*

    a) *Geographic, hydrographic, hydrological, climatic, ecological and other factors of a natural character;*

[63] Article 8: "Watercourse States shall cooperate on the basis of sovereign equality, territorial integrity, mutual benefit and good faith in order to attain optimal utilization and adequate protection of an international watercourse"

b) *The social and economic needs of the watercourse States concerned;*
c) *The population dependent on the watercourse in each watercourse State;*
d) *The effects of the use or uses of the watercourses in one watercourse State on other watercourse States;*
e) *Existing and potential uses of the watercourse;*
f) *Conservation, protection, development and economy of use of the water resources of the watercourse and the costs of measures taken to that effect;*
g) *The availability of alternatives, of comparable value, to a particular planned or existing use.*

2. *In the application of article 5 or paragraph 1 of this article, watercourse States concerned shall, when the need arises, enter into consultations in a spirit of cooperation.*

3. *The weight to be given to each factor is to be determined by its importance in comparison with that of other relevant factors. In determining what is a reasonable and equitable use, all relevant factors are to be considered together and a conclusion reached on the basis of the whole.*

As there are well over 350 or more active international agreements associated with transboundary water (TFDD, 2013). While some of these may well reflect inequities associated with power asymmetries in the basin (Zeitoun & Mirumachi, 2008), they have presumably been considered as both equitable and reasonable by the countries entering into them in many cases. Article 6, therefore, is less of a threshold to be achieved by independent opinion and more of a guideline to assist negotiations with the concerned parties. Indeed, the list of factors should be viewed less a substantive goal to be achieved and more as a procedural goal to have included in the duty to communicate. The emphasis on consulting in a spirit of cooperation is key (Article 6 (2)). Moreover, the obligation in Article 5 to "attaining optimal and sustainable utilization" of the watercourse insinuates interdependency as part of cooperation (Article 5 (2)).

Recent Efforts to Forward the Water Agenda

The history of transboundary water law and the move to create a global framework for understanding and agreement has been impressive in recent decades. The world's water resources specialists have recognized that a more comprehensive, cross-sectoral approach to managing water resources is needed to achieve sustainable development. In determining equitable and reasonable uses, linkages between economic sectors and degradation of the water environment should be identified, and preventive measures included in national economic development plans. Moreover, national plans should support the sustainable water use in the basin as a whole.

Some highlights of the global water agenda over the past few decades include: the Helsinki Rules (1966), UNESCO First International Conference on Water in Mar Del Plata, Argentina in 1977; the International Conference on Water and the Environment in Dublin in 1990;[64] the 1992 United Nations Conference on Environment and Development in Rio (UNCED); the 1st World Water Forum in Marrakech in 1997; the 1st Petersburg Round Table International Dialogue in 1998; the 6th session of United Nations Commission on Sustainable Development (CSD 6) held in New York in 1998;[65] the Millennium Summit of the United Nations in New York in 2000;[66] the 2nd World Water Forum in the Hague in 2000;[67] the International Conference on Freshwater in Bonn, Germany in 2001;[68] the Johannesburg "Rio Plus 10" Earth Summit occurred in 2002;[69] and, the 3rd World Water Forum in Kyoto in the spring of 2003;[70] the Berlin Rules (2004); and, most recently, the Fourth World Water Forum in Mexico, March 2006.

All of these meetings and gatherings have assisted in pushing the water agenda to the forefront in international development (Biswas, 2004). The acknowledgments that water is critical for our survival, and the recognized need for its sustainable management have been well established and is the first Key Recommendation of the World Water Report 2 (UNESCO-WWAP, 2006).[71] Article 10 of the Watercourses Convention indicates that in situations of dispute, the interpretation of equitable and reasonable should give special regard to vital human needs. Moreover, water is specified in several other human rights conventions, such as the Convention on the Elimination of all Forms of Discrimination against Women[72] and the Convention on the Rights of the Child,[73] as well as in one regional treaty, the African Charter on the Rights and Welfare of the Child.[74] Finally, the Geneva Conventions guarantee the protection of this right during armed conflict.[75]

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[64] See: Dublin Statement on Water and Sustainable Development www.wmo.ch/web/homs/documents/english/icwedece.html (08 October 2005)

[65] See: http://www.un.org/esa/sustdev/csd/CSD6.htm (08 October 2005)

[66] See: http://www.un.org/millennium/summit.htm(08 October 2005)

[67] See: www.worldwaterforum.net (08 October 2005)

[68] See: www.water-2001.de (08 October 2005)

[69] See: www.johannesburgsummit.org (16 October 2005)

[70] See: www.world.water-forum3.com/ (16 October 2005)

[71] WWAP 2006. The first Key recommendation of the UN World Water Development Report 2 was "We need to recognize that access to clean water is a fundamental right."

[72] See Article 14.2 (h) www.un.org/womenwatch/daw/cedaw/text/econvention.htm (18 October, 2005)

[73] See Article 24.2 (c) www.unhchr.ch/html/menu3/b/k2crc.htm (18 October, 2005)

[74] See Article 14.2 (c) www1.umn.edu/humanrts/africa/afchild.htm (20 October, 2005)

[75] See Article 89 of the Third Geneva Convention relating to civilians www.unhchr.ch/html/menu3/b/92.htm (18 October, 2005)

Also, in November 2002, General Comment 15 of the UN Committee on Economic, Social and Cultural Rights (CESCR) recognized the right to water as a fundamental human right.[76] While interpretations of the Committee through General Comments are not binding, it should commit the 145 states that have ratified the International Covenant on Economic, Social and Cultural Rights to ensure fair and non-discriminatory access to safe water for drinking and hygiene purposes.

Although, we might agree that access to safe and sufficient water is a basic human right, these are limited quantities of water. The majority of issues regarding allocation, use and maintenance lay in agricultural and industrial uses; and it is here where the greatest disparity of opinions lies.

Forwarding the Water Agenda

As we cannot control the weather, the solution to water allocation problems lies in better water governance. Water crises are increasingly about how societies govern the access to and control over water resources and their benefits and less about the technical issues surrounding the resource use. There is no coincidence that four of the eight key recommendations listed in the World Water Report 2 deal with governance issues surrounding water (UNESCO-WWAP, 2006).

That is not to say that technical innovations, such as drip irrigation or desalinization are inappropriate or unnecessary, but rather that they will be more efficiently achieved under the auspices of larger policies and good governance. If we are truly going to achieve sustainable water use in the future, the key lies in removing the political and social obstacles (Bernauer, 2002)

Policies for Meeting the Challenge of Sustainable Water Use

Policy interventions can be categorized to seek efficiencies of water use at three levels: the local user level, the basin wide level, and the global level (Hoekstra, 2005). Policies and actions at the local user level take the form of influencing behavior through pricing, regulations, and education. The choice of dual flush toilets or capturing rainwater at a household level are examples. While polices may be national or municipal, it is alterations at the consumer level where efficiencies are targeted.

[76] Committee on Economic, Social and Cultural Rights, General Comment No. 15 EC 12/2001/11. “The human right to water entitles everyone to sufficient, affordable, physically accessible, safe and acceptable water for personal and domestic uses is fundamental human right of all people”.

Technology is extremely important at the local consumer level. As water cannot be substituted, conservation technologies making water use more efficient will have large impacts on water consumption. With so much of our water being used in agriculture, massive savings can be made for water in the agricultural sector, such as drip irrigation or developing new species, which are drought and salt resistant (Smil, 2001). Likewise, potential for conservation exists in both domestic and industrial use.

Fresh water can be created from marine water, though is it costly. Desalination is becoming increasingly popular in arid areas such as Israel and Southern California and the middle east where access to traditional fresh water sources demands pumping large distances through different jurisdictions. Ownership and property right issues plague the South Western United States: the Central Irrigation District claims rights to 75% of California's share of water obtained from the Colorado River, and there is bitter controversy over urban and agricultural use (Hayes, 2003). Desalination provides an opportunity for urban areas to release themselves from the dependence on buying high priced 'agricultural' water.

The second or middle level is that of the water basin, where choices must be made with respect to allocation of water to various sectors including agriculture, public health, industry and the environment. This is primarily an institutional issue involving value judgments and assessments. Clearly, when the basin is shared between countries, management must become institutionalized at the international level and have a series of design elements which facilitate the peaceful and effective management of those resources (Hearns et al., 2014; Schmeier, 2015).

At the largest scale, water policies and actions can be developed to seek efficiencies at the global level. Some regions are water scarce while others are not, some regions also have a low demand and others do not; unfortunately, there is no positive relationship between availability and demand. Countries like Canada, while per capita large users of water, use relatively little of their available resource. While other countries like Egypt use as much as 98% of their available water (Allen, 2001; Gleick, 1996).

It is argued that virtual water, if taken into account during policy development, could help alleviate water shortages by growing things where they can be easily grown and trading to places where they cannot. Nowhere, has this been achieved at a greater extent than in the Middle East, which ran out of water in the mid 1990s and exists by importing water intense crops like wheat. (Allen, 2001). Egypt, for instance, simply cannot feed itself. In 2002, Egypt's population was over 60 million and increasing at a rate of over 1.5% annually (World Bank, 2004). It had to import over 40% of the wheat its people consumed (FAO 2004). This is despite the fact that technology and double cropping from irrigation and fertilizers allow Egyptian fields to produce 5.6 t/ha of wheat, comparable to that of many European countries ((Aquino, Carrion,

& Calvo, 2000)). While Egypt is in perhaps one of the most drastic situations, it is the case throughout much of the Middle East and Asia that countries are no longer able produce the food they need. The solution is to import food products, like wheat, that require high levels of water for production.

In the Okanagan Valley of British Columbia, water stress has caused concern for fruit growers. In turn, there has been a shift from water intense products such as apricots to lower water consuming, but much higher value, crops like grapes to support the wine industry, which not only has higher costs associated per pound of fruit but also has immense value added aspects in terms of wine production through intensive processing of the raw material (S. Cohen et al., 2006).

While it is true that a shift towards incorporating virtual water planning will help develop more efficient policies for water use, virtual water policies will have to be linked to trade policies to ensure that the reason for its promotion is not lost in pure economic incentives. Global and regional trade agreements, like the General Agreement on Tariffs and Trade or Mercosur, must accept that the 'objective' of the exchange in goods is to balance water deficits and not necessarily to enhance trade *per se*. Countries like Egypt necessarily depend upon the global grain trade to feed their people and are in a precarious situation. Any event that could alter the cost of grain will be potentially devastating for 'virtual water' dependent countries. As with the realization that green-house gas emissions, ozone and other atmospheric components are of global concern and require global strategies, so too will the challenge of managing water in the 21 Century.

Indeed, we can be confident that as systems are evolving for carbon trading to address green-house gas emissions and the exclusion from traditional intellectual property rights of certain agricultural landraces thought to be key to maintaining genetic diversity,[77] so too will a global convention emerge linking water and trade through virtual water.

The focus of this thesis, however, lies in the middle ground at the basin level. Here choices must be made with respect to allocation of water to various sectors, including agriculture, public health, industry, the environment and its maintenance. Allocation is primarily an institutional issue involving value judgments and assessments. It will invariably incorporate efficiencies found at the local user level (conservation technologies, drought resistant plants etc.) and can serve to propel efficiencies at the global level. Here, efficiencies will be derived

[77] The International Treaty on Plant Genetic resources for Food and Agriculture entered into force in June 2004. It lists species which are to fall under the 'multilateral' system for exchange between countries.

from basin wide policies, and, clearly, when the basin is shared between countries, this will demand international cooperation.

In terms of dispute resolution and the fostering cooperation, UNESCO created the Water Co-operation Facility in Paris in 2004. Its objective is to foster peace and cooperation among stakeholders using common shared water resources. Thus, provide the necessary resources, the favorable environment, political backing, professional support, and judiciary mechanisms, when requested. To date, it has evolved into a partnership between UNESCO, the World Water Council, and the Permanent Court of Arbitration in The Hague. More is needed, however, to foster cooperation to cope with the challenges of the 21 Century.

Conclusion

Proactive cooperation is fundamental to meet the challenges of the coming decades. Moreover, while great progress can be made in the realm of technical solutions for water conservation and water use with regards to international rivers, institutional mechanisms are paramount factors. Indeed, the principle factors governing whether basins fall into conflict or rise to cooperation are institutional rather than situational. In sense, cooperation is not passive but, rather, assertive; incorporating interdependence for the equitable, reasonable and sustainable management of international rivers. To help drive sustainability for the environment, the socio-economic needs and livelihoods of people, and stability between countries governments are going to need to be creative. Particularly, in regions where water scarcity may dominate the water paradigm, increasing linkages between energy, agriculture and trade are going to be required to address the shortfalls that climate change will throw at management systems.

In advancing national policies related to conservation of water and indeed the need for dialogue with neighboring countries the importance of domestic water use should not be underestimated as a mechanism for building public awareness. While domestic water use represents only a fraction of total water use all people need it and use it. In building public awareness regarding water consumption it allows decision makers to garner greater political support to develop more substantive policy choices in the agriculture sector and engage in transboundary water management.

Developing regional understandings and norms around water management in international basins is essential for effective future management. Not only will this demand a good deal of technical skill and information, but the greatest challenges at the international level will be developing dialogue and discussion between riparian states. Water, with its unique spiritual and physical properties can be a focal point for dialogue, cooperation and good neighborliness.

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Water Security:

Kabul River Basin

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Abstract

This paper tries to identify the water-security challenges Afghanistan and Pakistan have in the Kabul River basin. Ensuring water security is a challenge that both Afghanistan and Pakistan must address in the face of declining water sources due to climate change, over-use of water, over population and the mismanagement of water distribution and irrigation systems in the Kabul River Basin. Water security itself is a multifaceted and yet-to-be comprehensively analyzed topic. Many known and unknown variables and factors can affect water security. In fact, water security is already directly affecting the lifestyles of millions of people in the Kabul River basin, their livelihoods, health, social relations, environment, and economic strength. Afghanistan and Pakistan are not exceptions. With agriculture playing a vital role in economy of both countries, the two nations are utterly dependent upon their dwindling water resources. Thus, it is imperative that water security be addressed as an apolitical aspect of relations between both countries and should be addressed within the hydrological boundaries concerning both countries, and not just by the political boundaries.

Introduction

Water security is a multidimensional concept defined by many people very differently. Natural and social scientists have had their own definitions of the water-security term, whereas scholars from various disciplines have defined it instead from their own somewhat different perspectives (Cook & Bakker, 2012). Water security has also been defined as having sustained access to water. The domain the concept covers is vast and the effects that it has are numerous, which cannot limit the notion to one specific academic field. The lack of an agreed-upon definition has left a void and contributed to some apparent confusion that invites everyone to offer their own narrow definitions of water security that fit within their perspectives, positions, and needs, be they physical, human or environmental security, military security, or political influence over others. To some, it is a matter of national security when it comes to a water sources shared with other nations. This makes it an even more complicated matter to address.

Climate change, overpopulation, and poverty have been putting pressure all aspects of our lives in a globalized world. These factors have also been affecting water resources around the globe, causing even more stress, and in some cases and areas, even diminishing any known sources of water. Besides, increasing global temperatures have affected precipitation levels, run-off, groundwater recharge, and water quality and quantity throughout the world (Norman, Bakker, Cook, Dunn, & Allen, 2010). Local droughts and decrease in snow precipitation have strongly affected livelihoods in some areas, particularly as they have made life so difficult for those who must rely on raid-fed agriculture, or who have a nomadic lifestyle, which forces them to be constantly looking for places with water and grass to feed their livestock. In some cases, water security has been defined as having enough water allocated to someone. In fact, in such cases, “the fear of inadequate water supplies or the inability to manage excess supplies has always generated fear” (Tarlock & Wouters, 2009, p. 54).

Inadequate water supply can obviously threaten agriculture, which, in turn, threatens food supply or security and can force people to migrate to other areas with better water security. For example, in the 1980s the Ethiopian government had resettled thousands of people due to drought (IOM, 2008) since there wasn’t enough water to irrigate their fields, which had severely affected their capacity to grow enough crops. In the search for a better life and jobs, people commonly migrate to the cities where rapid urbanization creates further stresses upon the urban water resources that further undermines water security in these built-up areas. Such stress can affect urban life in many ways, especially by creating the potential for health problems and violence among the residents of the already overburdened metropolitan areas, who increasingly face water shortages and have problems in accessing clean water sources.

In agriculturally based economies, droughts and lower precipitation levels can become serious issues of national security and in such cases, to alleviate fears and have a dependable water supply, policy makers commonly turn to building more dams (Stewart, 2016). Dams also play important roles in addressing water-related hazards such as occasional floods and droughts that have been causing migration and rapid urbanizations in some areas. It is, sometimes, the sudden abundance of water floods that poses threats to humans and the environment. The irregular patterns, variable levels of precipitation, and lack of flood-control mechanisms in many underdeveloped regions have also caused miseries for the people living around water ways. For example, in 2010, millions of people in Pakistan were displaced by floods that started in the Kabul River basin in Pakistan and other tributaries of the Indus River and continued down to the south in Indus River basin, submerging one-fifth of the Pakistan lowlands and affecting more than 20 million people (Dixon & Schaffer, 2010). It is not just the lack of water but too much of it, multiplied by the lack of proper flood-control measures or appropriate infrastructure that cause so many water security concerns. This can be surprising in a place such as Pakistan where good engineers are available, although in Afghanistan where engineering education has been largely destroyed by decades of war, it is far more understandable. Moreover, agricultural practices and underdeveloped or poorly developed irrigation systems also affect water security. In Afghanistan for example, the last 40 years of conflict have already destroyed the irrigation system and severely affected access to water in rural areas. In Pakistan also for example, water-intensive crops and poorly managed and inadequately maintained irrigation systems are some of the other causes of water waste.

In many industrial and agricultural areas where environmental protection laws and regulations either do not exist or are not implemented, water ways and other sources of water are constantly under the threat of pollution, thus making the situation in the already water-stressed areas even worse. The practice of dumping raw sewage and other industrial wastes is widespread in the poorer and developing countries such as Pakistan, Afghanistan, and India where environmental laws and preventive measures are ignored (Sinfield & Shroder, 2016) (McNamara, 2016).

Figure 1. Photograph of two large tanker trucks that were dumping raw sewage into a dry stream channel near Kandahar in 2012 (photograph taken by L. Sinfield; from Sinfield and Shroder in Shroder and Ahmadzai, 2014). Such open dumping in uncontrolled areas contaminates the local soil, and potentially also the underground water, but is not regarded locally as a real problem at all because open defecation is practiced all over the country anyway. This, of course, contributes greatly to water insecurity by making the water unfit to drink.

Any threat to, or from water and its sources can have great implications for all our lives. It affects any peoples' economic capacity, health, environment, and livelihoods. As explained above, many, and sometimes competing definitions exist for water security (Norman, Bakker, Cook, Dunn, & Allen, 2010). This existing void of a comprehensive or all-inclusive definition for water security has also provided scholars with numerous opportunities to provide a broader definition. On the other hand, the United Nations defines water security as "*the capacity of a population to safeguard sustainable access to adequate quantities of and acceptable quality water for sustaining livelihoods, human well-being, and socio-economic development, for ensuring protection against water-borne pollution and water- related disasters, and for preserving ecosystems in a climate of peace and political stability*" (United Nations, 2013). This definition can suffice for now for our purposes, although we would encourage the scholarly community of water specialists to further refine this definition through a careful analysis of all the many possibilities in order to achieve a comprehensive and most useful definition that would provide greater succor to the water-beleaguered people of the world. This action would be quite useful to the people in the increasingly ever greater, water-stressed regions of the world.

Water insecurity has pushed people into taking unprecedented measures to safeguard their interests in having sustainable access to the scarce resources of water within their areas of political control and/or perceived influence; thus in some cases such as the areas surrounding the Nile River it created a potential for regional conflict between Egypt, Sudan, and Ethiopia in Nile River Basin when Ethiopia announced building a dam on the Nile River (BBC, 2014). At local levels, for example, famers have resorted to violence to expand their share of the water or to influence water-management systems. At national levels, geopolitical agendas and socio-cultural dynamics have played dominant roles in framing perspectives regarding water and water security (Petersen-Perlman, Veilleux, Zenter, & Wolf, 2012). Thus, in many national level cases, it has been the political boundary-defining perspectives, not the hydrological boundary that can encompass many countries or authorities. As a transboundary river basin, the political boundary of the Kabul River basin has been the topic of plentiful discussions both in Afghanistan and in Pakistan.

Water Security in the Kabul River Basin

Afghanistan

Covering parts of nine provinces to the east in Afghanistan, the Kabul River basin includes some 23% of the settlements in Afghanistan and approximately 35%, or around 8 million of Afghanistan's population. It is the most densely populated drainage basin in Afghanistan (World Bank, 2010) . More than 4 million Afghans live in Kabul city only (United Nations, 2015), which is the biggest city in the basin, and is already a greatly water-stressed place (Eqrar & Shroder, 2016).

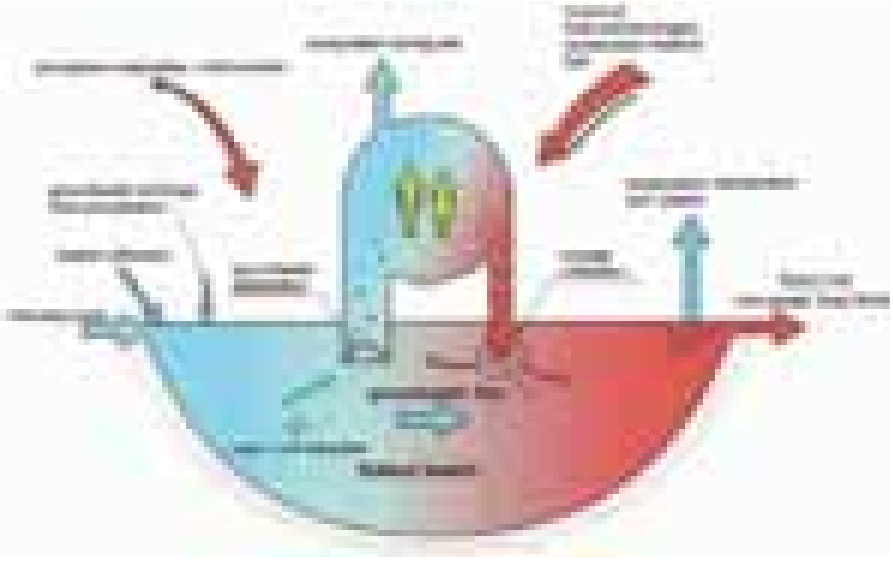
For Afghanistan, it is important that the population living in the basin of the Kabul River should have enough water to live securely and reap economic and agricultural benefits from the waters. The Gomal and Kurram rivers also flow into Pakistan from the Paktika and Paktia provinces of Afghanistan. Because there are no hydrologic data available for these two rivers, they have unfortunately been traditionally neglected in studies.

Droughts, seasonal floods, and water mismanagement have created more problems, not only for those who live in this basin, but also for others throughout the country. In a basin where one third of Afghanistan's population live, food security is unachievable without water security (FAO, 2013). Thus, one of the biggest concerns the Afghans have who are living in the Kabul River Basin is the availability of drinking water, with enough of it also being channeled into their fields with a sustainable and well-managed irrigation system to serve them.

Water quality is another concern for more than 4 million residents of Kabul city. At some locations, various pollutants such as nitrate, boron, and other solids have already polluted

subsurface water in Kabul city (Lashkaripour & Hussaini, 2008). At some locations, water quality is also affected by sewage due to the lack of proper septic canalization in the city. In fact, significant pollution has directly affected water security for the residents of Afghanistan's most populated city (Figure 2). A major reason for the water pollution in Kabul city is the unavailability of any proper sewage system. In many areas, residents have had to make sewage septic tanks in their houses to address their considerable waste-management problems. In some cases, these septic tanks leak and thus contaminate the subsurface water of that area, making water scarcity even worse. In fact, without any proper sewer system in the city to remove toilet and other waste properly, the only alternative to remove wastes into a septic system with its inherent drainage into the local shallow ground water is a certain recipe for health hazard and an obvious loss of water security. This is a widespread problem throughout South Asia, not only in Afghanistan where open defecation on the ground is so common.

Figure 2. Schematic diagram of flows of materials into and out of the Kabul River Basin, which shows incoming clean water sources, as well as the many sources of pollution into the surface and underground water (diagram taken from (Houben, Tunnermeier, & Himmelsbach, 2005)



Moreover, Afghanistan is currently relying on energy imports from its neighbors through transmission lines, at locations that go through very treacherous terrain prone to natural disastrous such as earthquake, landslides, snow avalanches, and flash floods, which collectively produce a strong national security concern. In the winter of 2015, Kabul city was in

the dark for many days because avalanches and heavy snow had cut off transmission lines in the Salang Valley (Nikad, 2015). Moreover, located in a politically quite unstable region of the world, Afghanistan would like to generate power by harnessing its own rivers, which quite clearly would involve water security to achieve the goal of being self-reliant to generate hydropower within the country. In fact, Afghanistan currently has three major reservoirs on Kabul River, the hydropower dams of Naghlu and Sarobi, as well as the Darunta reservoir, which is also used for irrigation purposes. With the average annual population growth of 3% (United Nations, 2015), water demand, not only in Kabul River Basin, but also in the rest of the country will grow ever larger, which will cause more stress on the water resources in the country.

The stress on water resources in the Kabul River Basin has been caused by factors such as the lack of precipitation in the high mountains of Afghanistan, the outdated water-management systems, decades of war, rampant poverty, the lack of maintenance of the water-management systems, overpopulation, overuse of water, and the receding glaciers. The irregular patterns of rain and snow fall caused by climate change have added more to the problems of water scarcity and stress in the Afghanistan - Pakistan region. According to a report produced by the United Nations and others, since the 1930s, the glaciers in Afghanistan have receded more than 50% (UNEP, 2007), (Shroder & Bishop, 2010) (Bishop, et al., 2014).

Figure 3 . The first map of glacier distribution in Afghanistan, with each green dot, mainly in the northeast of the country, representing about 10 glaciers. These data were compiled mostly from aerial photographs taken by aircraft in the late 1950s and early 1960s; but about half of these glaciers had wasted away to nothing by 2017. Glaciers are a vital source of meltwater that is used in irrigation of agriculture (Map taken from Shroder and Bishop, 2010).

During the last many decades of war, Afghanistan did not have the human capacity or the resources to make any significant developments in the basin of the Kabul River, or nearly anywhere else. The relatively smaller capacity that it has was totally consumed by incessant war and forced migration of the Afghan intelligentsia. However, during the same period of time in Pakistan, with the relatively well-maintained irrigation system and their huge population increase, water consumption in that country has been steadily increasing, especially from the Indus River to which Kabul river is a major tributary (Hanasz, 2011) . All these factors have been contributing to the emerging problems of water security in the Kabul River Basin and in its extension into the broader Indus River Basin of Pakistan. In addition, it is expected that the population in the Kabul River Basin in Afghanistan will also greatly increase, which is only adding ever more stress to the water-security problems that already exist.

Afghanistan's general engineering inabilities and internal political problems have created water insecurity for the Afghans that try to benefit from its rivers. Deposition of silt in the reservoirs behind Afghan dams has significantly diminished energy-production capacity and reduced the amount of water that can be stored in the dams, which directly affects irrigation and consumption. For example, the U.S. Army Corps of Engineers had planned to raise Dahla Dam of Kandahar [not part of Kabul River basin] to address the water-shortage problems in the area (Dowell, 2014). In dams on the Kabul River, silt is even visible behind the Sarobi and Darunta dams that has significantly diminished the capacity of both dams to store as much water as the once did. Removal of silt buildup behind any dam is exceedingly difficult and expensive, unless the dams were built originally with bottom-flushing floodgates or other means. This means that all dam building of the typical old-fashioned kind is inherently problematic, which can inadvertently add to time-detailed water insecurity of a different kind that needs to be planned for in any new dam construction projects. This is not often done, but should be planned for as yet another kind of security risk.

On the other hand, the neighbors of Afghanistan, especially including Pakistan argue that any development upstream in Afghanistan would have largely negative, socio-economic consequences for them. This most unfortunate foreclosure on Afghanistan's future is a source of major water insecurity in Afghanistan. The absence of water-flow measurement and observation mechanisms in the Kabul River Basin, and not sharing the currently available data with one another has created a void of information. This vacuum of data is unfortunately then filled with unchecked and biased figures in reports and policy papers at national and international levels. Such speculations do not help in making positive arguments that can help with addressing the emerging water security threats in the basin. In fact, it feeds into the environment of mistrust that already exists between both countries. Pakistan could greatly help in this situation by not acting in a belligerent fashion about the needs for Afghanistan to develop the water resources in its own country, but instead, for example, by offering its own good engineering skills to help Afghanistan produce a series of run-of-the-river, barrage-type hydroelectric or other dams on the Kunar tributary to the Kabul River that could help both countries simultaneously with their own electricity load-shedding problems (Figure 4). Assisting Afghanistan with the construction of the planned Kama Reservoir/dam on Kunar River, or not creating any hurdles for Afghanistan can be examples of cooperation. Kama Reservoir/dam can also be used to control floods that can save many lives and livelihoods at times when the abundance of water becomes a problem due to high level seasonal precipitation. Certainly, Pakistan has long experience in negotiating with its own archenemy, India, in their shared water problems, so it could use this experience to work out mutually beneficial engineering schemes between Pakistan and Afghanistan. Such a high level of true statesmanship between the two countries could be a major breath of fresh air between them.

Figure 4. (A) Map of the river drainages of the Afghanistan area. The Kunar region is shown just in the slightly upper right center (taken from Eqrar and Shroder, 2016, in Shroder and Ahmadzai, 2016); (B) Map of the drainages of the Kabul River showing the five major subdrainage basins (taken from World Bank, 2010).

Pakistan (Khyber Pashtonkhwa Province)

Kabul River becomes a part of the larger Indus River basin in Pakistan as it is contributing 21.5 km^3/year of water after entering Indus River (FAO, 2013). With additional water coming from its tributary, the Swat River, the amount of water increases before joining Indus River at Attock, at the border with Punjab province of Pakistan. According to the censuses of 1998, total population of the province was 22 million people (Government of KPK, 2017) and most of the population of the Khyber Pakhtunkhwa province lives in the Kabul River basin.

In fact, more than two million residents in Peshawar district (Government of KPK, 2017) directly depend on the water from Kabul River that is channeled through various canals meandering throughout the district of Peshawar, especially through Peshawar city. The continuous flow of water in these canals also naturally feeds the subsurface water of the district. Canals also irrigate parts of Shabqadar area and Charsada district. These canals originate at Warsak Dam on Kabul River, which is located approximately 20 km northwest of Peshawar city. The district of Nowshera (locally known as Now-Khaar), with a population of about a million-people located to the southwest of Peshawar city, is another district located along Kabul River that is directly affected by the water flowing into the Kabul River (Government of KPK, 2017).

With an average population growth of 2.8% and a quite rapid urbanization in Pakistan, the population of Peshawar city and areas around it will significantly increase every year. This is happening at a time when the Pakistani government is struggling within itself to control its own many population, ethnic, religious, provincial, and other problems. Pakistan has been unable for many years to even dam up the Indus River or any of its many tributaries to increase its hydroelectricity production. This inability is compounded by provincial politics and ethnic rivalries over land, with a result that it may appear to outside neighbors in Afghanistan, for example, that Pakistani pressures for the Afghans to not use more of their own water seems quite hypocritical.

Water contamination is another issue for the residents of Peshawar city. According to a study “most of the drinking water is contaminated before reaching households” (Inamullah & Alam, 2014). Untreated sewage from the residential areas of Peshawar city and industrial wastes are other reasons for water pollution and contamination that further reduce the availability of clean water. The city of Nowshera also suffers from water contamination that was caused by the floods of 2010. According to a study conducted by the Department of Environmental Sciences at the University of Peshawar, the flood in year 2010 not only destroyed infrastructure but also carried pathogenic organisms and contaminated subsurface water of the district. This contamination has caused many water-borne diseases such as cholera, dysentery, malaria and skin infections (Gul, Rehman, Hashim, & Ahmed, 2016).

Moreover, in Pakistan, it is estimated that about 90% of industrial and municipal waste that is largely untreated and commonly highly toxic, is dumped into open drains and infiltrated into aquifers (Mustafa, Akhter, & Nasrallah, 2013).

Water scarcity and management are already a thorny issue in Pakistan. For example, for many decades, the Pakistani federal government has been planning to build Kala Bagh hydroelectric dam on the Indus River south of Attock, but it has received strong opposition from other provinces that believe building the Kala Bagh dam will further harm the already delicate situation of water scarcity in their provinces. People in the northern provinces of Khyber Pakhtunkhwa Province (located in the Kabul River Basin) believe this dam will result in flooding of their fertile agricultural lands and threating their food security and their economy. The southern provinces of Sindh and Baluchistan believe that it will cut their share of water, which is adding further stress to the already depleted and overused water resource (Mustafa, Akhter, & Nasrallah, 2013).

The poor water-management system in Pakistan and the water- intensive crops such as sugarcane and cotton add more stress to the water resources, and furthermore, sugarcane and cotton fields are irrigated by flood methods, which itself results in a lot of water being wasted. In fact, the drip system of irrigation that can help in efficiently using water is almost unknown to the farmers in Pakistan, although this technology has been widely known for many decades. The province of Khyber Pakhtunkhwa produces around 15% of Pakistan's total sugarcane. Moreover, about 40% of the water is wasted in the water delivery systems due to improper design and unmaintained watercourses (Khan, 2012). A 40% waste is a huge problem for one of the most populated countries of the world that is already suffering from water shortages. This situation is not sustainable and will have adverse effects on the continuously growing population and their wellbeing.

The effects of climate changes on glaciers in Afghanistan are also felt in Pakistan since the Kabul River feeds from the Afghan glaciers, except for the Kunar River which also comes from the glaciers in the Chitral area of Pakistan. Both counties share the problem and the impact will be larger in Pakistan given its the size of population and the concomitant larger need for water. Thus, the water problem is not just an Afghan problem but a serious regional difficulty shared by both countries that will require a joint effort by Pakistan and Afghanistan.

Transboundary Disputes and Risks

One of the sticking issues between Afghanistan and Pakistan will be managing the Kabul River basin. Each country has its own plans and priorities on how to deal with the crises that can emerge from mismanaging water, the population growth, and the dependence on water from the Kabul River, as well as the quantity of water and its effects on agriculture. Most of the concerns

are about the quantity of water, as well as, to a certain extent, the water-related hazards that affect many aspects of the lives of the people living in the basin. The Afghan government is already planning to build multipurpose dams on the Kabul River on its side of the basin and it has already attracted attention and in occasion, the considerable ire of the Pakistani government (Khaama Press, 2016).

Afghanistan argues that it has been underspending its waters and has let them flow unimpeded without any interruption for a great many years to its neighbors. The reasons that Afghanistan cites are the past four decades of war and instability that have hindered any sort of development projects on the Afghan rivers and diminished the Afghan technical capacity to initiate any projects.

The risks associated with continuing with the status quo are that they will multiply the impacts of the shortage of water for the people of both countries living in Kabul River Basin. As time passes, population increases, and irrigation systems don't get developed and maintained, it will become far too costly for both counties to address the problem of water security in the future. However, this does not mean that both countries should independently continue with their development plans and errantly think that no risks will be associated with building dams or developing new irrigations systems. Any developmental project needs to be thoroughly studied and analyzed so that all sorts of unforeseen problems are not too much of a shock when they occur.

Afghanistan and Pakistan would first need to identify their needs fairly precisely, as well as their levels of water stress. The United Nation's Food and Agriculture Organization (FAO) measures the stress level of water by calculating water withdrawal as a percentage of the total renewable water resources\ (Mustafa, Akhter, & Nasrallah, 2013). According to the FAO the level of water stress in Afghanistan, as of 2002, was 31 percent and for Pakistan, it was 71 percent (United Nations Food and Agriculture Organization, 2002). Stresses are considered to be high if the percentage is higher than 25 (Mustafa, Akhter, & Nasrallah, 2013). So, this means that both countries are facing water-stress problems that need to be addressed before they can get to a more manageable level, if indeed that is ever going to be at all feasible. But the numbers show that clearly why Pakistan is so very nervous about its water-stress problems. This, of course, means that Pakistan should, so to speak, bend over backwards to be accommodating to Afghanistan. In fact, by doing so, Pakistan could set an example as a good neighbor so that Afghanistan would be able to move into a domestic political position that would enable it to work beneficially to try to accommodate Pakistan's water needs as much as is feasible

Already faced with water stress, both countries cannot afford to be continually ignoring each other's legitimate needs, be they long or short term, when we know that the population growth in both countries seems inevitable and will cause more demand for water in the coming

years. Both countries will need to share the hydrologic data in a quite transparent and internationally obvious manner, because transboundary water allocation and policy implementation have clear socio-economic and ecological implications for all the parties involved in the water allocation (de Loe, Varghese, Ferreyra, & Kreutzwiser, 2007). Unfortunately, cross-border terrorism and security problems in Afghanistan and Pakistan have forced both countries to shelve all other initiatives or potential partnerships and dialogues. This will no doubt have long-term ramifications for the people of Afghanistan and Pakistan who live in the area of the Kabul River basin. Moreover, any developments, upstream or downstream, on the Kabul River will have political, economic, and social consequences in Pakistan that need to be addressed appropriately if the intention is to work together and avoid any disagreements that can result in conflict.

Possibilities for Joint Efforts?

Afghanistan and Pakistan do not have any agreement, shared water-management mechanism, or a treaty on the Kabul River or other smaller shared rivers in the basin. The Kabul River, as Afghanistan's most populated river area in the basin, has been the main point of contention and discussions between both countries. Directly and indirectly, both countries have tried to find common grounds but the efforts have not born any fruit so far.

Lack of trust, cross-border terrorism, as well as the long-standing feud over the Durand Line of the nominal border between the two countries are some of the major reasons why it is not expected that both countries could develop a water treaty addressing transboundary water issues. However, this does not mean that no mechanisms can ever be formulated for cooperation. In fact, the Indus Water Treaty between Pakistan and India is a perfect example of cooperation between two nations who do not share many common ambitions but still have an important mechanism to address common water-security challenges. India and Pakistan have dedicated professional institutions tackling their water issues at national levels. Afghanistan would also need to develop such a capacity to institutionalize its effort of harnessing its water and providing well-informed policy options. Some possible solutions might involve setting up a new joint water commission between the two countries under the auspices of the United Nations or the World Bank, for example. A wise course of action would be for the World Bank to become directly involved at the request of the both governments, because that would also provide a ready source of funding for joint ventures, because such an action would play very well in international quarters where other funding could be obtained. A third-party facilitation by an organization such as World Bank would also help lay to rest some of the international anxiety that Afghanistan will not work with its neighbors on any of its water issues because it fears being manipulated by outside pressures as a result of its own lack of understanding about hydrologic phenomena and water engineering.

The possible joint efforts, as mentioned previously in part, might include a new commission for joint investigation for a new cross-border linkage of development of the Kunar River drainage basin, with its headwaters in Pakistan, middle reaches in Afghanistan, and tributary junction with the Kabul River in Afghanistan at Jalalabad. With a joint commission or working group facilitated by a trusted third party such as the World Bank or Asian Development Bank and established between the two countries to produce hydroelectricity to be shared by both or purchased by Pakistan, and a more integrated irrigation network with new canals, the presently almost completely undeveloped nature of the river might help serve as a springboard for additional peaceful and shared development. With engineering expertise largely provided by Pakistan, geographic terrain supplied largely by Afghanistan, financing provided largely by the World Bank, the US Agency for International Development, and other sources in Asia, a whole new water-development paradigm could be created for the region. An additional incentive to make this and other beneficial aspects happen would be for Pakistan to offer to form a new higher educational effort on water for Afghan students that could help the considerable hydrological-education deficit in Afghanistan. The movement of young adults as students in both directions across the borders might be feasible, especially because it is already being done in an informal way on an individual basis anyway. All these mutual arrangements do not necessarily require a formal larger water treaty which is politically not feasible in Afghanistan. Smaller measures can prove helpful if an environment of mutual trust is created.

Conclusion

Regional political and economic instability has been adding to the complexity of shared water-resources management in the region, but at the same time, if managed well, shared water resources could become a platform upon which both countries could move toward better cooperation, if they chose to seriously address these issues fairly (Petersen-Perlman, Veilleux, Zenter, & Wolf, 2012). Water security in Kabul River basin cannot just be attributed only to climate change or to the amount precipitation and glacier meltdown in the high mountains of Afghanistan. It will also depend on how the use of water is governed to meet the demands and needs created by multiple causative factors, which includes climate change as a compounding variable.

Addressing water security challenges, wherever and whatever they might be, requires informed decision- making efforts that can help in reducing uncertainty caused by lack of information (Hope, Hansen, Mutembwa, & Schlessinger, 2012). Information that covers all aspects of the causes of water scarcity is needed to prepare for the needed measurements and to take necessary actions to avoid any challenges caused by water scarcity or too much sudden abundance of it. In a void of information caused by deficit of trust between Afghanistan and Pakistan, informed decisions cannot be made for the betterment of people living in the Kabul River Basin. Given the ratios of population in both countries, Pakistan has the most to lose from not addressing water-security challenges in a cooperative and fair manner.

Afghanistan has not had any major river-harnessing projects in the last 50 years, and as a country in great water need, it most certainly will not abandon its efforts to address its needs from the Kabul River. Any upstream developments, no doubt, will have consequences for Pakistan. However, this does not mean that any developments upstream should be considered only as ambitions with negative consequences. Instead, in a new spirit of cooperation engendered by profound mutual needs, the two countries should seek to band together to help each other overcome at least some of their water problems by seeking joint solutions however possible. Not doing anything positively and fairly to address water-security problems in not a solution, inasmuch as the youth of the two nations demand better solutions from their governments rather than the tiresome bellicosity that has existed all too much in the past. Such threats of violence produce nothing and are actually quite counterproductive in that milieu where people have unfortunately become rather habituated to such negativity. Non-violent and friendly negotiations are far more likely to produce mutually beneficial results.

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Afghanistan's Aspirations for Energy Independence

Water Resources and Hydropower Energy for a Long-Run Sustainability

Mir Sayed Shah Danish & Najib Rahman Sabory

Abstract

This paper presents the historical developments (since 1893) and opportunities for the future direction of water resources and hydropower in Afghanistan. The importance of water resources for hydropower energy production and irrigation, to ensure national security and prosperous socioeconomic development, is also addressed. At present, Afghanistan relies heavily on electricity imported from neighboring countries (80%, Breshna Sherkat, 2016). However, Afghanistan is endowed with substantial renewable energy resources. Among these, water potential is the main clean source available for electricity generation and irrigation. The water resources of Afghanistan mainly comprise five major basins (36 sub-rivers), and the rivers of three of these basins flow into neighboring countries, which has caused water resource trans-boundary disputes and is a challenge for the government of Afghanistan. The lessons learned from past trends, and recommendations for future development related to Afghan water resources and hydropower, are discussed. The establishment of sustainable development practices that account for social, technical, technological, political, and environmental concerns for long-term sustainability is evaluated. In the future, renewable energy technology exploitation will contribute to emerging economies. This study is the first of its kind to address water resources and hydropower development in Afghanistan.

Keywords

Afghanistan; Hydropower; Water Resources Management; Irrigation Systems; Economic Development

Introduction

Rapid economic growth and changes in human civilization have led to dramatic increases in demands for water resources and electricity. Nations are therefore faced with the challenge of maintaining cost-effective and clean energy production. With today's cutting-edge renewable technologies, we must move forward with sustainable preservation of water resources and generation of electricity from renewable energy sources. Efficient exploitation of hydropower technologies for residential, commercial, and industrial uses, with comprehensive management of water resource for multiple purposes, provides an opportunity to mitigate energy dependence, ensure efficiency and reliability, reduce pollutant emissions, and develop an economy. The specific merits of hydropower, such as in applications other than electricity generation (e.g., irrigation and mill operation), the ability to handle seasonal changes in electricity demand and production, and its predictable behavior, make it preferable over solar and wind technologies.

The aim of this paper is to present hydropower development and exploitation in a broad context. Deployment of renewable energy technologies (especially hydropower) is considered essential for modern societies. Herein is an overview of various aspects of national water resources and hydropower, based on the present status and future trends, to develop cost-effective hydropower technology feasibility for sustainable long-term mitigation of greenhouse gas emissions. In addition, types of irrigation systems, a description of water management processes, and a proposed framework for hydropower planning and performance in Afghanistan are addressed. Furthermore, the potential feasibility of hydropower in Afghanistan is discussed, taking into account existing barriers and impacts of political stability and socio-economic development. This study is one of the first scholarly publications on water resources and hydropower development in the context of Afghanistan.

An Outlook on Energy Resources in Afghanistan

World over, each country is endowed with the renewable energy sources necessary for inexhaustible production and supply of electricity. These diverse sources of renewable energy have the potential to provide all the electricity a nation needs many times over [1]. The technical potential of renewable energy sources is limited by the lack of technology, and by economic and environmental constraints [2]. By the end of the nineteenth century, the industrial revolution and development of civilization worldwide led to commercial generation of electricity with great strides in improving efficiency [3]. On the whole, a growing population and the need to limit greenhouse gas emissions in the twenty-first century encouraged the world to turn to long-term sustainable measures for energy provision. The most important criteria for sustainable energy production are accessibility, affordability, disparity, safety, use efficiency, supply and production efficiency, cost effectiveness, and environmental impacts on air, water, and soil quality.

In 2012, hydropower increased by 3% worldwide to an estimated total installed capacity of 990 GW, which consisted of 67% of the world's total renewable energy capacity [4]. Types of hydroelectric power stations are related to the terrain where power plants are located, and can generally be classified as follows: moving water power stations, or diversions (low slope and no water reservoir capacity); reservoir power stations, or impoundments (with large amounts of water stored upstream of the turbines); or reversible power stations, or pumped storage (rational use of two hydraulic reservoirs where backwater is pumped to the top reservoir during periods of low demand) [5, 6]. Of the various renewable energy sources, water resources offer particular advantages in Afghanistan, which include:

- utilization for other purposes, such as irrigation, laundry, fishing, and fishery, in addition to electricity generation.
- compensating for seasonal peaks in electricity demands, especially in the winter season in Kabul [7].

All energy technologies have advantages and disadvantages. Hydroelectric power is clean, has low exploitation and maintenance costs, can accommodate seasonal energy demands with reserved capacity, has predictable behavior relative to solar and wind sources, and can be used in irrigation, mills, and flood harvesting. Conversely, its disadvantages are the high initial cost per installed kilowatt, generators are often located at great distances away consumption points, time-consuming construction, dependence on meteorological conditions that can vary from season to season and location to location and types of technologies [6, 8].

In July 2009 in Afghanistan, the Renewable Energy Directorate (RED) was created, and renewable energy policy was developed whereby the Ministry of Energy and Water (MEW) and the Ministry of Rural Rehabilitation and Development (MRRD) were tasked with the responsibility of developing renewable energy in urban and rural areas [9, 10]. In September 2010, the German Corporation for Technical Cooperation presented a draft version of their "Afghanistan Rural Renewable Energy Strategy Action Plan until 2014 and Development Objectives until 2020" [10] for the Afghanistan Energy Programme.

Hydropower Development Trends in Afghanistan

Afghanistan is a landlocked mountainous country that lies between South Asia and Central Asia. Afghanistan is endowed with overflowing rivers and natural resources, but effective electricity production from these resources remains sparse.

The first electricity generation station with the capacity to power 40 lights was built in 1893 in Kabul, the capital of Afghanistan, and subsequently more small power plants were built: a 20 kW thermal engine in Arg (the presidential palace) in 1911, a 19 kW engine in Jalalabad Province in 1915, and a 15 kW engine in Paghman in 1916.

Energy production from water is a simple process that can be conducted by harnessing and harvesting energy from moving and storage of water resources. In 1920, the first hydropower plant was built in Jabal Al-Saraj, and began operating in 1922 to electrify Kabul [11]. The years 1935 to 1951 were advantageous for hydropower plant construction and development in Afghanistan. Later, because of decades of political conflict and civil war, the development of the energy sector was terminated and the existing infrastructure was destroyed as well.

The momentum of hydropower development has since resumed after the collapse of the Taliban regime in 2001, and the government of Afghanistan declared a new electricity policy in 2003 [12], which encouraged private-sector investment in electricity production and provided facilities to start business in Afghanistan. The Afghanistan national power grid was severely damaged during the political conflict, and less than 30% of the population now has access to electricity [13]. Still, the planned covered areas seem insufficient as the demand exceeds the supply. However, after the political transition in 2001, factors such as security problems, and lack of investment assurance and government support discouraged electricity sector investment, despite the new energy policy. These economic conditions led to a national deficit of electricity energy and imbalance between energy supply and demand.

Some micro-hydropower projects were funded under the National Solidarity Program (NSP) in conjunction with the administration of the MRRD (2003), and the supervision of the World Bank. The aim of this program was to empower rural communities and to strengthen the relationship between rural communities and local governments. The NSP was implemented in a variety of projects such as supplying drinking water (25%), irrigation systems (21%), transportation (20%), livelihood improvement (11%), education infrastructure (5%), miscellaneous services (1%), and provision of energy such as diesel generators, micro-hydropower, and solar power (17%) [14] for rural communities. In 2010, electricity demand for the entire country was reported to be 2,348.7 MW [12].

Hydropower Share of Electricity Generation in Afghanistan

Hydroelectricity is the most widely used type of renewable energy in Afghanistan. Hydroelectric dams have become the central focus because of the availability of the necessary environments and low environmental impact. Historically, hydropower has been the most promising resource for electricity generation in Afghanistan, and most electricity generation has been concentrated in the central part of the country because of the high population density and the presence of industrial centers and residential areas.

Afghanistan has about 123 years of experience in hydropower generation with enough potential to generate tremendous electricity from hydropower projects, not only for self-sufficiency but also to export electricity to Pakistan and India as well. After decades of

consecutive wars, the government of Afghanistan has stepped forward to rehabilitate the country, particularly in the energy and electrification sectors. The three most important types of hydropower schemes are storage, run-of-river, and pumped storage. Of these types, run-of-river type and storage type hydropower dams are used in Afghanistan, although the latter is rare.

Reports indicate that more than 160 micro-hydropower plants are installed in Afghanistan, with a total usable capacity of 75.14 MW [10, 15]. Among these micro-hydropower plants, 30–40% are not operational [9]. Power from reservoir-type hydropower dams, with a tremendous capacity for reserved controllable water flow to handle peak electricity load, is often utilized. Before the conflict, reservoir dams were constructed for electricity generation and irrigation. The details of these hydropower projects are shown in Table 1.

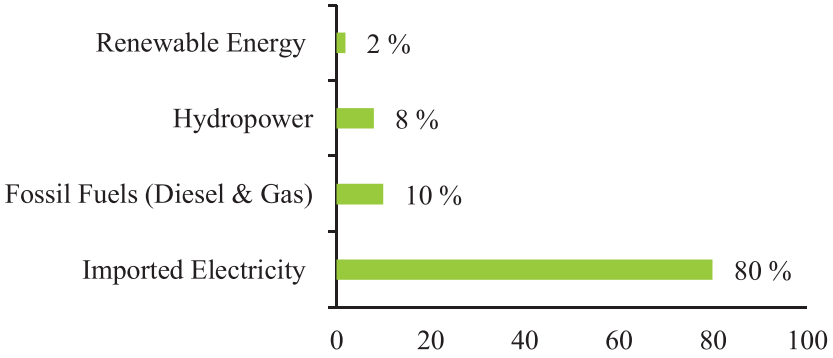
Table 1: Details of the existing hydropower and irrigation dams, distinguishing river basins (Lashkaripour & Hussaini, 2008)

Dam name	Type of dam	Purpose	Volume (Millions of cubic meters)	Installed capacity (MW)
Mahipar	Diversion dam	Electricity generation	0.2	66
Naglu	Gravity dam	Electricity generation	580	100
Surubi	Diversion dam	Electricity generation	6.5	22
Jabal-al-Seraj	Diversion dam	Electricity generation	-	2.4
Chak Wardak	Diversion dam	Electricity generation	-	3.3
Darunta	Gravity dam	Irrigation/electricity generation	41	11.5
Ghaghe	Earth dam	Irrigation	15	-
Other small dams	Different	Irrigation/electricity generation	-	-

Afghanistan's electrification network is consolidated into three major grids: the North Eastern Power System (NEPS), the South East Power System (SEPS), and the Western Power Grid (WPG) with Kabul, Kandahar, and Herat as the major load centers, respectively [17]. Afghanistan mainly relies on electricity imported from neighboring countries; imported energy

accounted for about 80% of the nation's consumption in 2016, and is backed by power purchase agreements (PPAs) (Figure 1).

Figure 1: Shares of electric power supply sources in Afghanistan at the beginning of 2016 (Da Afghanistan Breshna Sherkat, DABS, 2016)



According to the Afghanistan Power Sector Strategy (2007), the rate of access to electricity was 6–10% in 2007, and proposed to reach 25% by 2010 and 33% by 2015 [15]. Access to electricity has increased from 6% in 2003 to more than 30% in 2016, and is anticipated to reach the target of 65% over the next five years [17]. However, Afghanistan is still heavily dependent on imported electricity, as shown in Figures 2 and 3.

Figure 2: Installed generation capacity (MW) in Afghanistan (Da Afghanistan Breshna Sherkat (DABS), 2015)

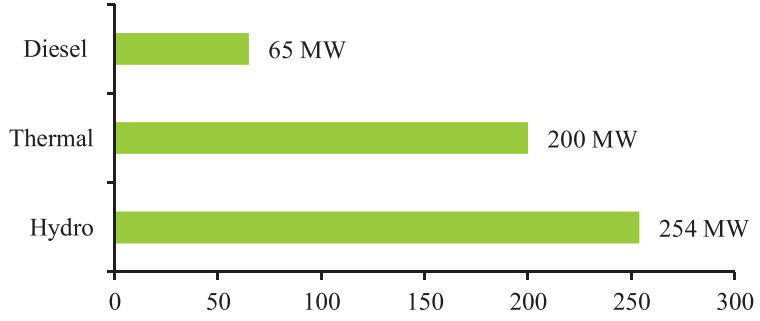
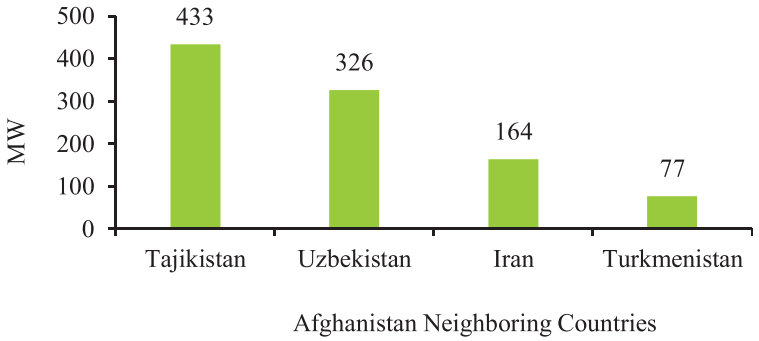


Figure 3: Transmission capacity for power import (MW) in Afghanistan (Da Afghanistan Breshna Sherkat (DABS), 2015)



Hydropower Plants in Afghanistan

Water flow volumes in Afghan rivers vary, with higher flow rates from April to August. After 1893, there was an increasing trend toward electric power production and consumption. Numerous electricity-generating facilities were built and utilized throughout the country. The largest share of this capacity depends on water resources [18]. The Naghlu hydroelectric power plant is one of the largest hydroelectric dams in Afghanistan. Construction of this dam began in January 1960, and was completed in 1968. This dam has four turbines, with an installed capacity of 100 MW [19]. It operates in Kabul, is approximately 110 meters high from foundation to crest, and is situated below the confluence of the Kabul and Panjshir rivers [13]. War over the last two decades greatly damaged part of the Naghlu hydroelectric power station, but in February 2013, the third turbine was reactivated to increase the power-generating capacity by 25 MW [10].

The Jabal Seraj power plant is the country's oldest hydropower plant; its construction began in 1916 on the Salang Sea at an altitude of 1,600 m above sea level, during the reign of Amir Habibullah Khan [5]. The major hydropower plants in Afghanistan are Naghlu, Surobi (in Kabul, with two turbines), Mahipar (40 km east of Kabul, two running turbines), Kajaki one and Kajaki three (in the south, providing power to 50,000 families in Kandahar and Helmand provinces [20]), Darunta (in Jalal Abad, with three turbines), Pul-e-Khomri (in Baghlan, with two turbines), Grishk (in Helmand, with two turbines), Assadabad (in Kunar), Charikar, Jabal-u-Saraj (in Kabul) [21], Ghurband (in Parwan), and Istalif (in Kabul) [17, 22]. In total, eight hydropower stations are fed by the Kabul River and its tributaries, which produce 80.4% of the installed capacity. Detailed information about existing and planned hydropower plants is given in Table 2.

Table 2: Existing and planned future hydropower plants in Afghanistan (Power Sector Master Plan, 2013)

No	Power plant	River	Estimated installed capacity/after refurbishment/construction (MW)	Date of commissioning	Tentative planned date of refurbishment/construction	Annual energy generation after refurbishment (GWh)	Estimated cost of refurbishment (1×10^6 USD)
1	Naghlu	Kabul	100	1967	Mid-2013	413	90
2	Sarobi	Kabul	22	1957	Completed	188	25
3	Mahipar	Kabul	66	1967	Completed	152	80
4	Darunta	Kabul	11.5	1964	2012	85	14
5	Assadabad	Kunar	0.7	1983		4	1.2
6	Charikar	Ghorband	2.4	1973	Needs rehabilitation	14	3.6
7	Jabul Seraj	Salang	2.5	1920	Needs rehabilitation	14	3.6
8	Ghorband	Ghorband	0.3	1975	Needs rehabilitation	2	0.6
9	Kajaki (1 & 2)	Helmand	33	1975	Needs rehabilitation	272	40
10	Grishk	Helmand	2.4	1957	Needs rehabilitation	14	3.6
11	Pul-i-Chomri	Pulikhumri	4.12	1950	2013–2015	24	6

12	Pul-i-Chomri 2	Pulikhumri	8.79	1962	2013–2015	49	13
13	Baghdara	Panshir	210		2021	968	600
14	Surobi 2	Kabul	180		2021	891	700
15	Kunar A (Shal)	Kunar	789		2022	4,772	2,000
16	Kajaki Addition	Helmand	100		2021	493	300
17	Kukcha	Kukcha	445		2022	2,238	1,400
18	Gulbahar	Panshir	120		2021	594	500
19	Capar	Panshir	116		2021	574	450
20	Kama	Kunar	45		2021	223	180
21	Kunar B (Sagai)	Kunar	300		2021	1,485	600
22	Kajaki Extension	Helmand	18.5		2015	91	90
23	Olambagh	Helmand	90		2021	444	40
24	Kilagai	Kilagai	60		2021	297	250
25	Salma	Hari Rud	40		2020	197	200
26	Upper Amu	Amu Daria	1,000		2023	4,955	2,500

The availability of water resources in Afghanistan makes feasibility studies of hydropower dams essential; therefore, these resources have received region-wide attention. In 2015, Chinese experts surveyed the Kunar River and reported an estimated installed capacity of 1,500 MW [23, 24]

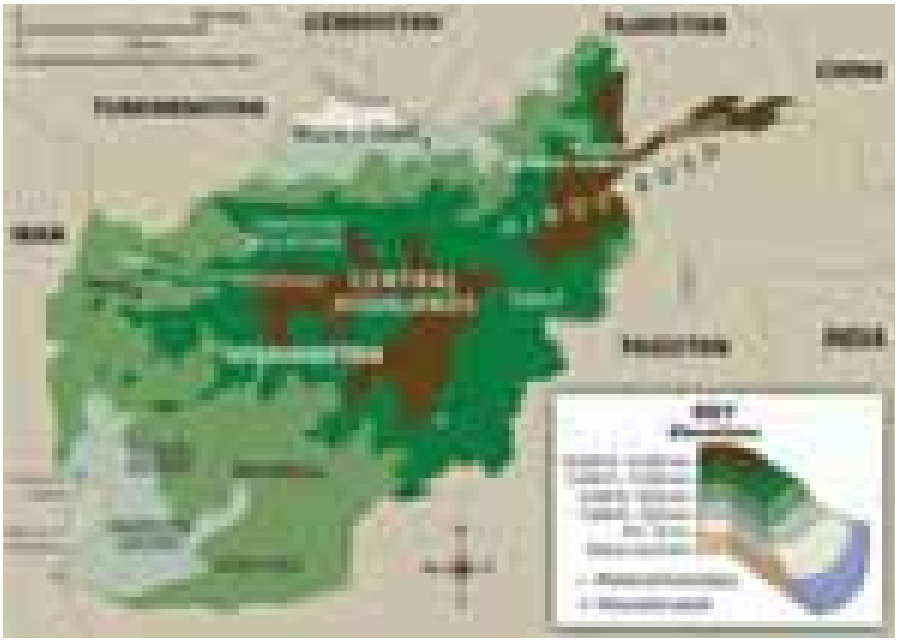
Hydropower and Self-Sufficiency

Energy independence is essential for a nation's success as it enables less reliance on foreign energy suppliers. Energy independence and encouraging diversification of domestic sources directly correlates with socio-economic prosperity and development of national stability. To achieve independence from imported energy for domestic needs it is necessary to develop and reconfigure self-sufficient energy policy in Afghanistan. The country has sufficient primary energy resources to achieve this goal, but requires advanced technology and expertise to transform these into usable secondary energy. Some domestic natural resources are cheap and readily available, especially hydropower potential which can be cost-effectively utilized in many ways with less-developed technologies and low costs. However, sustainability and limiting greenhouse gas emissions must be ensured.

Water Resources in Afghanistan

Afghanistan is a land-locked, mountainous country with elevations from below sea level to more than 3,000 m above sea level in Salang (Figure 4), dominated by a dense network, and is located at a strategic location at the crossroads of three main regions: the Indian sub-continent to the east, Central Asia to the north, and the Middle East to the west [16]. The climate of Afghanistan is arid to semi-arid with average annual rainfall of 285 mm [10, 25, 26].

Figure 4: Topographic map of Afghanistan (Afghan Geodesy and Cartography Head Office)



Recently, salient steps have been taken by the government of Afghanistan to develop hydropower and related human resource capabilities that are currently lacking. The impacts of water diversion and seasonal water shortages must be considered before such projects are implemented, and detailed techno-economic, political, and environmental feasibility studies must be undertaken [27]. The available data and statistics on the Afghan water and hydropower sector are limited, and access to official documents has been restricted. Lack of access to the basic information about water resources in the country has led authors to compile available data from reliable sources, with some mismatches.

Water Conservation Reserve Potential in Afghanistan

Rainfall

The average annual rainfall in Afghanistan ranges from 77 mm in Zaranj to 1,170 mm in South Salang. The annual maximum mainstream river flow from snowmelt and torrential rain occurs in March and April, and over 80% of discharge is recorded from April to September [28]. The annual rainfall varies, with high levels in the northeast (Figure 5) and low levels in the southern and western desert climates (100–300 mm and 200–400 mm per year, respectively) [27]. Recent reports [19] have demonstrated the potential for available rainwater to be harvested effectively. The average monthly rainfall for different zones is clearly expounded by [28], as shown in Figure 6 and 7.

Figure 5: Rainfall statistics for Afghanistan, based on average river basin areas (Bhattacharya, Azizi, Shobair, Mohsini 2004 & Rout, Lee, 2008)

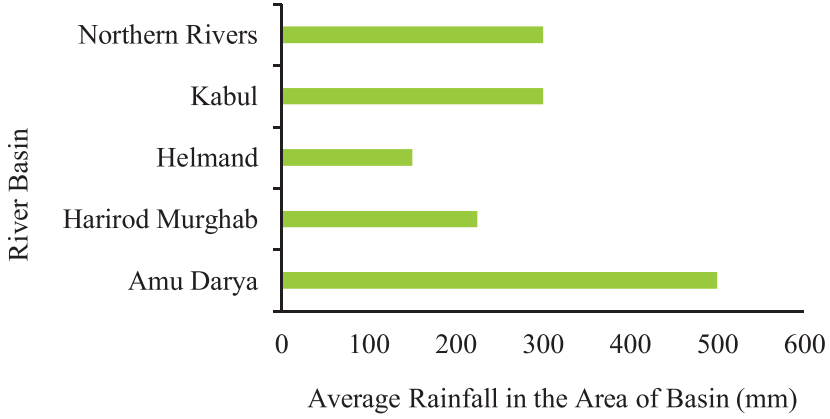
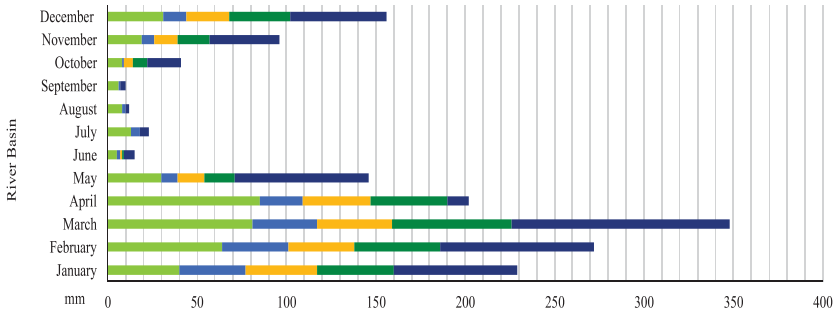


Figure 6: Average rainfall in different basins during a year in each zone (Bhattacharya, Azizi, Shobair, Mohsini 2004 & Rout, Lee, 2008)



	January	February	March	April	May	June	July	August	September	October	November	December
Eastern rivers	40	64	81	85	30	5	13	8	6	8	19	31
Soouthern rivers	37	37	36	24	9	2	5	2	1	1	7	13
Western rivers	40	37	42	38	15	1	0	0	0	5	13	24
Northern rivers	43	48	67	43	17	1	0	0	0	8	18	34
Northeastern rivers	69	86	122	12	75	6	5	2	3	19	39	54

Figure 7: Mean annual precipitation in Afghanistan (Aini A, 2007)

Surface Water, Groundwater and River Basins

Surface water flowing over the land is estimated to account for 88% of water resources, and 12% is groundwater [29]. Traditionally, small-scale micro-watershed harvesting has been beneficial in Afghanistan, and assessment is required for a strong transition from micro-watersheds to innovative large-scale water conservation projects [27].

Figure 8: Afghanistan's river basins (Afghan Geodesy and Cartography Head Office)

Traditional methods of water harvesting must be rehabilitated in parallel with introduction of new large-scale and technologically advanced projects [27]. The Amu Darya, Harirod-Murgab, Helmand, Kabul, and Northern rivers have the five largest river basins and have good potential for water supply and conservation (Table 3; Figures 9 and 10).

Table 3: River basins and sub-river area and capacity, in Afghanistan (Watershed Atlas of Afghanistan)

No.	River basin	Area (% of entire river basin)	Water (% of entire river basin)	Rivers
1	Amu Darya	14	57	Amu Darya, Panj, Wakhan, Kunduz, Kokcha
2	Hari Rod-Murghab	12	4	Hari Rod, Murghab, Koshk
3	Helmand	41	11	Helmand, Arghandab, Tarnak, Ghazni, Farah, Khash
4	Kabul	11	26	Kabul, Kunar, Pangshir, Ghorband, Alinigar, Logar
5	Northern	11	2	Balkh, Sar-e-Pul, Khulm
6	Non-drainage area	10	-	

Figure 9: Topographic map of Afghanistan's river basins (AIZON, 2016)

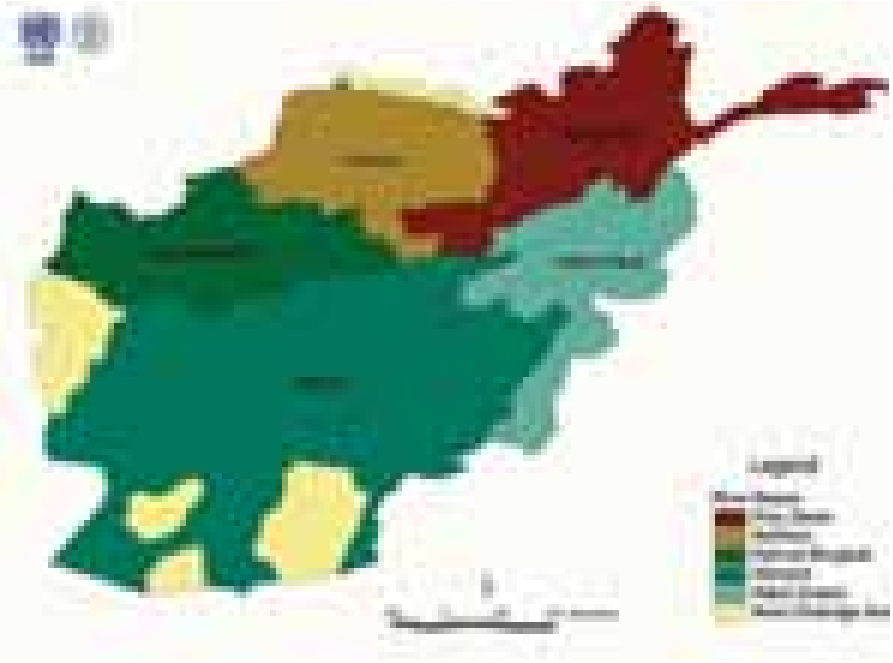
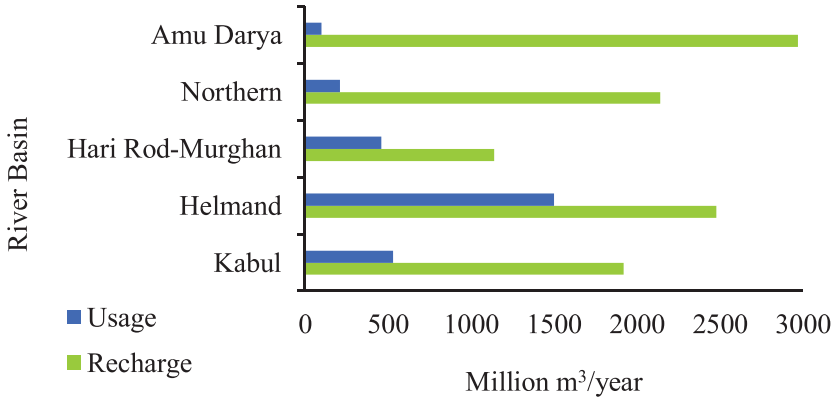


Figure 10: Status of groundwater in Afghanistan (million m^3/year) (Rout, Lee, 2008)



Water Resources Management

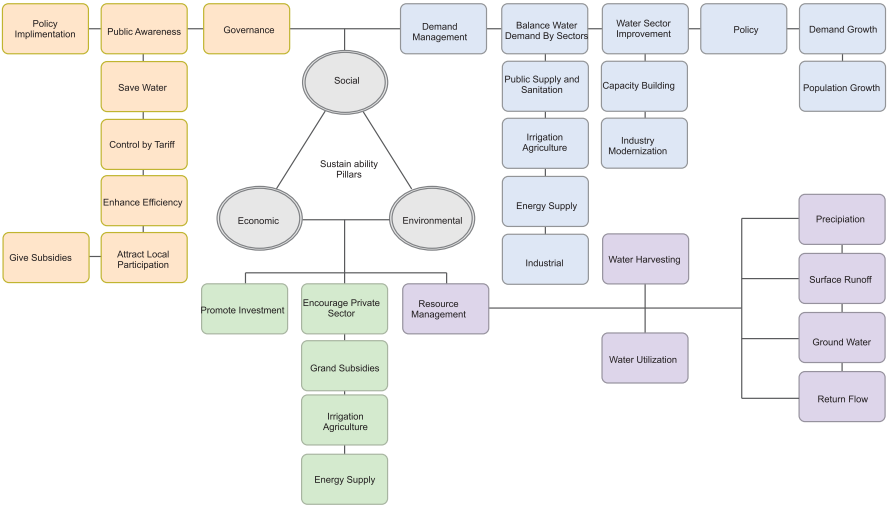
Proper management of water resources is critical for economic prosperity and improving the quality of life in a country [32]. According to [33], water resource management is defined as the effort to supply the required volume of water with acceptable quality at the proper place and proper time, which includes several principal components. These components are delineated as water balance, which is related to social, economic, and political conditions, as shown in Figure 11 [33]. This figure shows the proposed conceptual framework for better management and exploitation of water resources in Afghanistan, which almost all ministries that are stakeholders in water resource management (the Ministry of Energy and Water, Ministry of Rural Development and Rehabilitation, Ministry of Agriculture, Ministry of Urban Development Affairs, and the Ministry of Foreign Affairs) have agreed to implement. In a regional scheme, the major objective of water resource management and governance is to provide equal opportunities to all stockholders involved in water resources management and governance. However, because of continued political instability and weak governance, Afghanistan has been not able to manage water resources effectively. The main components of water resource governance and management are as follows [34, 35]:

a) Political commitment
b) Institutional arrangements
c) Legislative framework
d) Financing and incentives

e) Public participation
f) Managerial tools and instruments
g) Capacity development

In recent years, the government of Afghanistan has taken significant steps in improving water management, and developing water resources infrastructure as a fundamental factor for socio-economic improvement. These actions are compiled in the Afghanistan National Development Strategy (ANDS) 2008 [37]. The framework for Afghan water resources management within the pillars of sustainability is conceptualized in Figure 11.

Figure 11: Factors influencing sustainable water resources management processes (conceptual framework for Afghanistan water management)



The Integration Water Resource Management (IWRM) system, with the help of feasibility studies conducted for small, medium and large water infrastructure projects, has represented some of the major government interventions in recent years, as shown in Table 4.

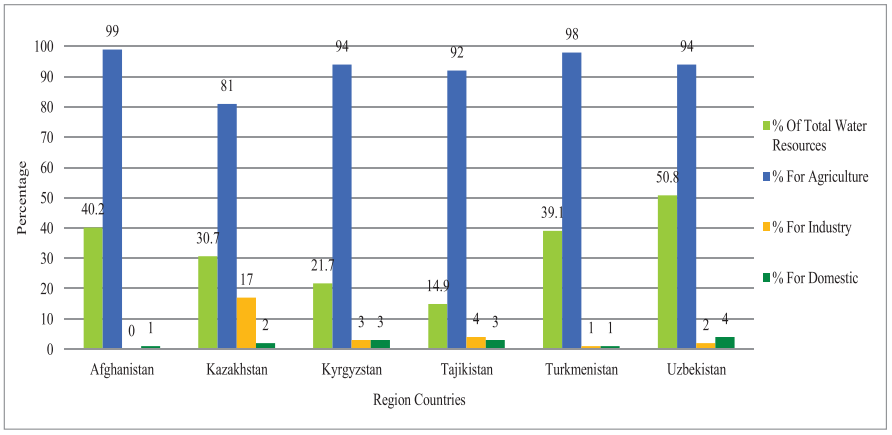
Table 4: Regional Countries Human Development Indicators (MEW Monthly Magazine, 2016)

River basin	Number of projects (under construction in 2016–2017)	Allocated budget (k$)
Panjshir sub-river (Mahmood Raqi)	29	5,753
Saal and Khuram sub-river (Khost)	9	1,977
Kunar sub-river (Asad Abad)	2	456
Kabul sub-river (middle)	11	2,180
Kabul sub-river (lower, Nangarhar)	4	4,327
Panjshir sub-river (upper, Bazarak)	1	101
Changha sub-river (Ghardiz)	1	179
Midan Shahr sub-river	1	13
Ghorban sub-river (Charikar)	2	3,805
Lugar sub-river (Puli Alam)	2	1,595
Laghman sub-river (Mehtarlam)	4	407
Total		20,795

Utilization of Water Resources beyond Hydropower

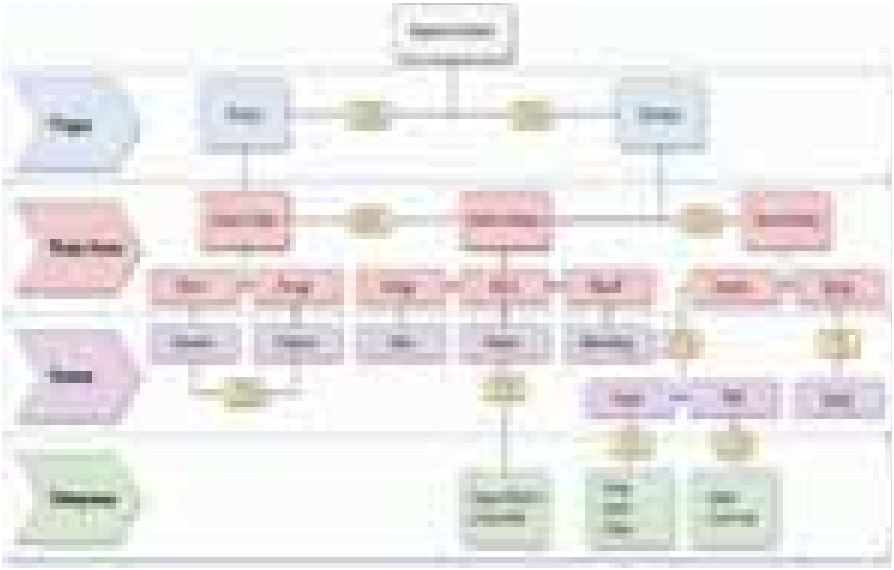
Agriculture is the economic activity of 78% of the Afghan population, and accounts for two-thirds of the national income [16, 21]. At first glance, it is notable that despite the abundant water resources, Central Asian countries (Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan, in addition to Afghanistan) still have limited access to water, with a limit of 1,000 m^3 per capita considered to represent water scarcity. This finding contradicts the common perception that Central Asian countries have high access to water resources. However, it is important to realize what is behind the limited access to usable water resources. Studies have shown that environmental issues that originated after 1960, uneconomical and inefficient utilization of water resources, lack of appropriate policy, and sufficient politics have led these countries to unhand ample opportunities that yield weak socio-economic development [33]. As a paradigmatic, access to freshwater per capita in the Central Asian countries is easily turned down by the figures in Figure 12.

Figure 12: Water availability and use in Central Asian countries Rahman, Varis, 2008)



Efficient use and harvesting of water resources refers to the balance of management and utilization. In Afghanistan, almost 84% of water resources are used for irrigation because of a lack of water harvesting dams and misuse of water resources for personal benefits in agriculture [30]. Agriculture is the foundation of the country's economy, but there are more cost-effective and affordable options to be implemented, such as karizes (similar to canals), which have had satisfactory results. Different irrigation systems are common in Afghanistan, as shown in Figure 13. According to the Ministry of Energy and Water, irrigation water resources in Afghanistan are divided into rivers (84.6%), springs (7.9%), arhad (0.5%), and karizes (7%) [30]. The figure demonstrates that karizes are little used, although case studies have shown that they not only are affordable but also can help to reserve water in hydroelectricity generation plants [39].

Figure 13: Classification of types of irrigation and water harvesting systems in Afghanistan Rout, Lee, 2008)



Water Resources: A Reason for the Interference of Neighboring Countries

The state of the country has caused several incidents based on regional energy politics to occur between Afghanistan and neighboring countries. In 2010, Afghan police accused Iran of attempting to halt construction of the Salma Dam in Herat province [40, 41]. In 2011, Pakistan raised concern after the announcement of India's assistance in building twelve hydropower dams in the Kabul River basin [40, 42]. In another case in 2011, a dispute was raised over water resources from the Helmand River along the Afghanistan–Iran border [43]. Indeed, Pakistan and Iran have both expressed concerned that the development of water and hydropower infrastructure in Afghanistan would negatively affect their interests [40]. The political instability and conflict in Afghanistan have bestowed these countries with flowing water of immeasurable worth. These incidents have shown the significant role of regional politics for fulfilling the Afghan government's objective of achieving energy independence.

Water Resources and Economic Progress

Hydropower enables improvement of livelihoods, industrialization, and socio-economic development, with advantages in terms of life expectancy, education, and other metrics. Indicators for national human development comprise various factors such as gross national product (GNP), gross domestic product (GDP), and purchasing power parity (PPP), as shown in Table 5. According to the [47], GDP per capita (PPP-based) is the gross domestic product converted to international dollars (which have the same purchasing power over GDP as a U.S. dollar does in the United States) using purchasing power parity rates and divided by total population.

Table 5: Human development indices for Afghanistan and surrounding countries in 2015 (ADB, 2008)

Country	GNP		GDP		GDP (PPP based) (1 × 10^9 USD)
	1 × 10^9 USD	Country rank	1 × 10^9 USD	Country rank	
Afghanistan	6.96	115	19.681	206	104
Pakistan	107	43	270.961	170	27
Iran	187	32	396.915	95	20
Turkmenistan	6.63	118	44.362	99	86
Uzbekistan	13.5	94	65.953	160	64
Tajikistan	2.18	156	8.045	192	140
China	2,264	4	11,384.763	113	1

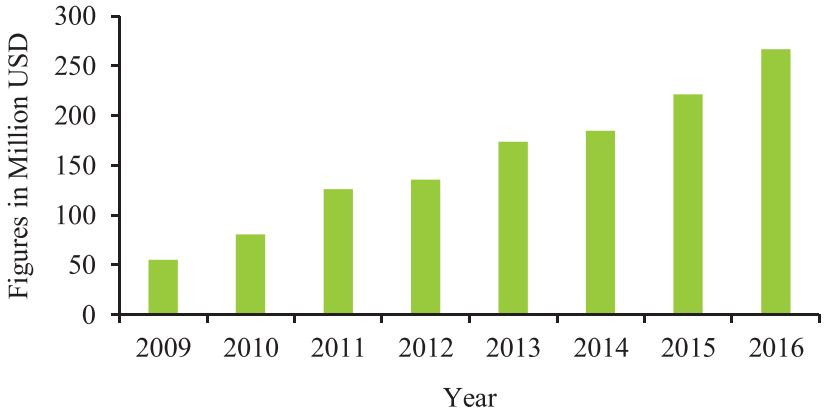
With 36% of its population under the poverty line, Afghanistan is one of the poorest and least developed countries in the world [48]. Fluctuating GDP growth rates (a 21% increase in 2009/10 and 8.4% decrease in 2010/11) marked by distinct ups and downs indicate socio-economic sensitivity in Afghanistan [13].

Afghans' access to electricity is between 18.50 and 19.25 kWh per capita annually, according to the difference references [49]. The government committed to rebuilding damaged electricity infrastructure and build new infrastructure to meet domestic demand, and asked multilateral and bilateral donors to fulfill the proposed target of 300 MW by the end of 2015 (which is not yet achieved), with the aim to become a net energy exporter by 2022 [10].

Political transitions such as economic downturn in the Central Asian republics after the collapse of the Union of Soviet Socialist Republics (USSR), and a decade of conflict in

Afghanistan, have affected the development of sustainable energy technologies in these countries. The cost of imported energy has shown an increasing trend, with the projection for 2016 showing an increase of about 365% from 2009 to 2016 (Figure 14).

Figure 14: Afghanistan investment in energy import from 2009 to the beginning of 2016 (Da Afghanistan Breshna Sherkat (DABS), Commercial Department)



Barriers to Water Resources and Hydropower Development

The current major bottlenecks in Afghanistan, in terms of formulating energy policies, are the lack of a flexible framework and professional cadres [12]. Access to water is a pressing need, to be achieved through democratic governance, integrated water management risks, and local participation. However, access to water is sought without protecting ecosystems and managing water resources.

Furthermore, ensuring efficiency is the most important point for hydroelectric power plants in Afghanistan, which are running at efficiencies several times lower than their installed capacity. Therefore, they must be comprehensively assessed based on accepted methodologies, and factors influencing efficiency, such as net income, the number of employees, financial assets, installed capacity, energy savings, electricity generation, precipitation, technology investments, and commercial revenue [4], must be thoroughly evaluated for optimization. The barriers to hydroelectric power generation in Afghanistan are addressed in a wider context in this section. The main points can be briefly listed as follows:

1. Lack of a sufficient budget to build feasible hydropower plants, and lack of willingness in the private sector to invest in hydropower plants because of security concerns and uncertain conditions.
2. Lack of sufficient information for feasibility studies and a practical plan for implementation.
3. Lack of coordination, and the interference of multiple organizations in planning and implementation of renewable energy projects.
4. Lack of involvement in long-term projects from international financial institutions. Typically, donors have been interested in supporting short-term projects.
5. Lack of a mechanism to attract national and international investment/loans to initiate and operate hydroelectric power projects.
6. Lack of rules and regulatory sovereignty over power brokers who are unwilling to pay the costs of electricity.
7. Lack of sufficient use and management of payback, cash flow, tax-in-tariffs, and other financial factors to support economic reserves.
8. Lack of modern automated and digitalized systems for electricity production to end-use consumption.
9. Lack of stability to implement micro-hydropower projects in rural areas.
10. Lack of technical expertise and dominate workforce for hydropower plant operation and maintenance.

Discussion

After decades of political instability and civil war, Afghanistan has transitioned to a new government that has taken steps to develop hydropower. However, the lessons learned [16] indicate that integrated water resources reservation and management are needed to meet the country's needs.

Water demand management at the river basin level, and water resources protection, are required to stabilize and improve quality and quantity of water resources.

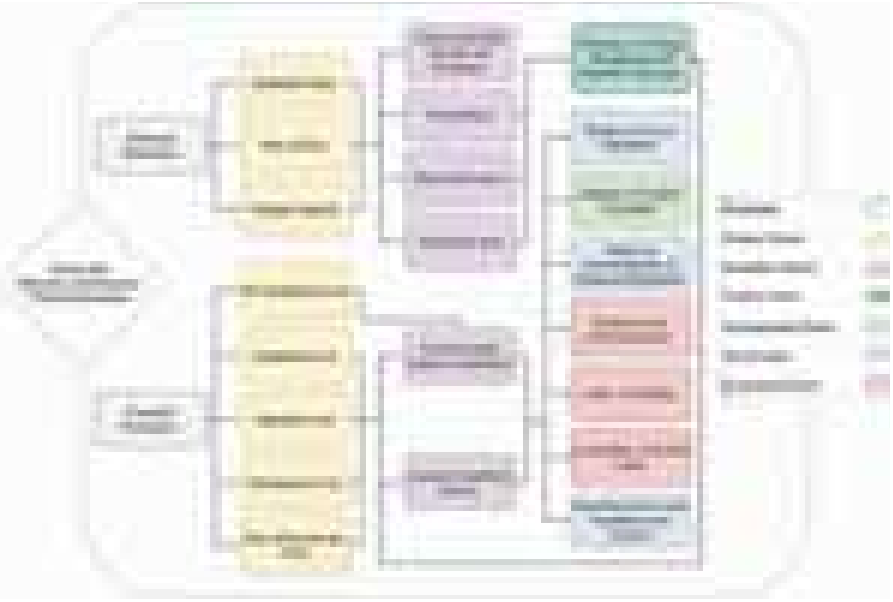
Four main factors compromise hydropower dam development in Afghanistan [21]:

a) Lack of security
b) Institutional transitioning
c) Absence of transboundary dialogue and agreements
d) Uncertain and fragmented aid provision

The poor performance of micro-hydropower plants, especially in rural areas, is a consequence of improper operation and inadequate maintenance. Somehow, inadequate feasibility and nonconformance of effective parameters for planning hydropower plant projects present salient challenges of operating under installed capacity.

According to the [5], for a hydroelectric power plant to be efficient, it is crucial to address the primary, secondary, tertiary, environmental, social and economic factors together, as shown in Figure 15 [5].

Figure 15: Factors that influence hydropower plant planning and performance



One sustainable solution is deployment of significant renewable energy resources (especially hydropower technologies) through public and private investments, and establishing long-term mechanics for sustainable energy deployment. Recently, incentive programs have been proposed to encourage private-sector investment in hydropower technology; micro-hydropower is a part of this. Overall, to overcome energy challenges, domestic generation capacity needs to increase, transmission and distribution systems need to be rehabilitated and enhanced, and energy sector policies need to be improved.

Conclusion

This study discusses water resources potential and technology development in Afghanistan, with a particular focus on available hydropower potential, and its prospects for future self-sufficiency in electricity generation and economic prosperity. This discussion is followed by an analysis of barriers to the construction of small- and large-scale hydropower plants, and efficient water resource management in the context of ensuring long-term sustainability. Finally, hydropower development options, feasibility considerations, and recommendations are explored, and conclusions are drawn for establishing a framework for hydropower development and water resources management in Afghanistan. Among the three main types of hydropower schemes (run-of-river, storage, and pumped storage), the first two are common in Afghanistan. Access to and proper use of water resources are fundamental factors in the socio-economic development of a nation. Trans-boundary water resource development and management affect regional stability and conflict prevention, and are a highly politicized issue worldwide. A large proportion of the water in Afghanistan either flows to or is shared with neighboring countries, which can lead to trans-boundary disputes. Such problems remain challenges for the Afghan government. Finally, this study presents a useful reference for water resource and hydropower development practices across Afghanistan in the context of long-term sustainability, and may serve as a useful analogue for other under-developed countries.

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