CICP Working Paper

No. 40

Water resources usage and management in the Mekong region and Cambodia: challenges and future prospects

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March 2011

With Compliments

Published with the funding support from
The International Foundation for Arts and Culture, IFAC

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Acronyms

ASEAN	Association of Southeast Asian Nations
BDP	Basin Development Plan
BOD	Biochemical Oxygen Demands
CCAI	Climate Change and Adaptation Initiative
CLMV	Cambodia, Lao PDR, Myanmar and Vietnam
FMMP	Flood Management and Mitigation Programme
FP	Fisheries Programme
IWRM	Integrated Water Resource Management
LMB	Lower Mekong Basin
MRC	Mekong River Commission
NAPA	National Adaption Programme of Action to Climate Change
NGO	Non-Governmental Organization
UNEP	United Nations Environment Programme
WQMN	Water Quality Monitoring Network

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1. Introduction

Water insecurity has the capacity to fundamentally influence all segments of society and can have disastrous consequences with the potential to threaten national, regional and international security and stability. Although Southeast Asia can be argued to enjoy above average annual per capita water resources;[1] crucial factors such as population growth, urbanization, declining water quality, dam construction, industrialization and climate change continuously increase the pressure on these resources. Due to this, the current need of potable water resources is likely to increase drastically in the coming decades which have the capacity to cause urgent regional water scarcity, if not mitigated and managed properly.

As such, water resource management is a pressing security issue of the regional community which should be addressed immediately. As it also has the capacity to seriously threaten the stability and security of the region in terms of flooding, draught and an increase in refugee flows, it is imperative that regional representatives thoroughly address this issue. As it might seem less alarming and pressing than for example military invasion or military threats, water security tends to be ignored and overlooked somewhat. This view needs to be altered at once and attention must be paid to sustainable and proper water resource usage and management, to mitigate and manage these threats, in order to establish regional water security.

The Mekong River connects many Southeast Asian countries; 22 percent of the river is located in the People's Republic of China, 3 percent in the Union of Myanmar, 25 percent which runs through Lao People's Democratic Republic, 23 percent in Thailand, 19 percent in the Kingdom of Cambodia and 8 percent which is located in the Socialist Republic of Vietnam.[2] In this sense the Mekong Delta is an essential water resource, central to the discussion on the current state of water resources usage and management in Southeast Asia. Accordingly, this paper will emphasize the importance of the security

[1] According to statistics provided by the World Bank, visible below, and in accordance with the Falkenmark water scarcity indicator.
[2] Mekong River Commission. *Impacts of Climate Change and Development on Mekong Flow Regimes; First Assessment - 2009.* No. 29. June 2010. p 1.

of the Mekong River as an indispensable life source which supports water, agricultural, environmental, economical, food and human security.

As water insecurity is often presented as a non-military and non-traditional security threat, debates surrounding it tend to apply a traditional security framework of analysis which emphasize state security, territorial sovereignty and the absence of conflicts. This paper will seek to apply a non-traditional framework for analysis which will emphasize regional integration and cooperation. This is done in an attempt to escape the analysis of non-traditional security threats through the lens of traditional security paradigms and dogma. Consequently, the concept of security will in this paper not only refer to the absence of conflicts but also to the existence of regional cooperation, the maintenance of multilateral political relations and reciprocal trust.

The purpose of this paper is therefore three-fold. Firstly, it will provide an assessment on the current water resources usage and management in Southeast Asia with a specific focus on the Mekong region. A similar analysis will follow in chapter 3, from a Cambodian perspective. These assessments will be carried out while recognizing the current challenges and prospects for attaining regional and national water security. The fourth chapter will provide an analysis where recommendations for possible ways forward and appropriate policy responses to these issues will be discussed.

2. Water security in the Mekong region

Definitions

Water security and water insecurity

Water security will throughout this paper refer to the capacity to ensure the safe access to available and potable water resources which meets the demand of its intended

purpose.[3] Water insecurity will therefore be defined as a state reached when this access is jeopardized and where available water resources are no longer sufficient or cannot be used for its intended purpose.[4] It should be noted however that many different definitions of water security and water insecurity exists. The above mentioned definitions, for example, refer to a connection between availability of resources and a need and demand, and as such, the definitions of what water security truly entails is dependent on how one would define that need.

This is a noteworthy point as this paper will argue that the countries of the Mekong region do not face immediate water scarcity, however, driving forces of water insecurity are numerous and if not mitigated, it is likely that the Mekong region in the future would be faced with urgent water stress.[5] Due to for example population growth, the water need of the region is bound to change in the coming decades, and as such, water insecurity should be viewed as an alarming issue which needs to be addresses urgently to prevent future situations of water scarcity.

Water scarcity

The term water scarcity or water stress is subject to much ambiguity. Water scarcity will in the present paper refer to the inability of current water resources to meet the posed demand. It will be expressed in terms of water availability per capita, in accordance with the Falkenmark Water Stress Indicator.[6] As such, water stress will in this paper be defined as a state reached when freshwater withdrawals are greater than 20 percent of the total renewable resources.[7] When withdrawals reach 40 percent or more, the country is considered to have reached a stage of high water stress. In this sense a country can be argued to face water stress when having less than 1,700 cubic meters of water per capita and year.

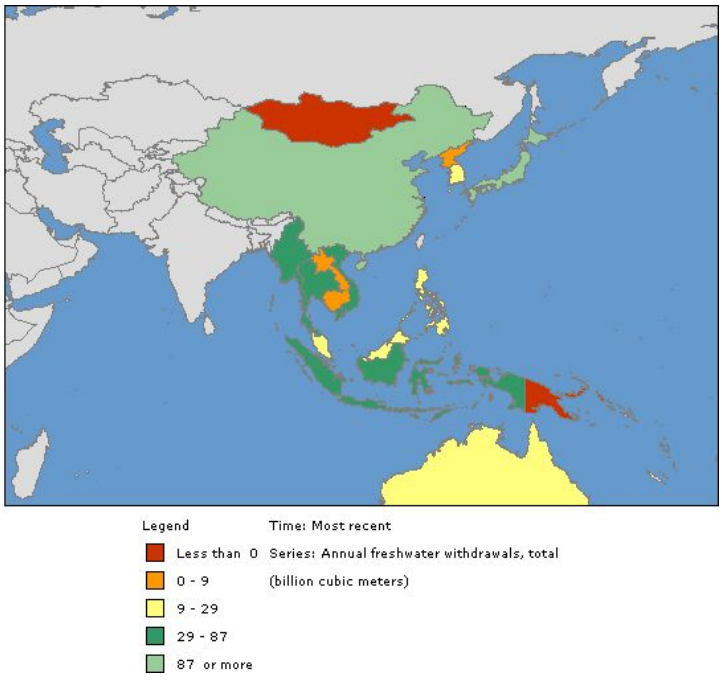
[3] Rijsberman, R, Frank. "Water Scarcity : Fact or Fiction ?". *Agricultural Water Management.* 2006. p 6.
[4] Ibid.
[5] Please see below for definition of this term.
[6] The most widely used indicator of water scarcity according to Frank, R, Rijsberman.
[7] Definition derived from the United Nations Environment Programme, UNEP.

Framework of analysis

The framework of analysis applied in this paper has an overarching perspective of the desirability of good governance and this approach emphasizes regional governance as a means to handle driving forces of water insecurity. For clarification purposes, good governance will in this paper refer to a focus on sustainability and the establishment of policies and legal frameworks that promote a long-term sustainable water resources management. The application of this viewpoint will include a perspective of how water resource security and water stress should be seen in a context of how the use and management of land and forest resources is inescapably inter-linked to water resource security. This paper will thus argue how security realization in these different sectors must function analogous, when seeking to establish a sustainable strategy for future water resources security.

Current water usage in the Mekong region

The current total freshwater usage in the Mekong region varies significantly between the individual countries, as can be seen in figure 1.[8]



[8] It should be noted that the total withdrawal can exceed 100 percent in cases where extraction from nonrenewable aquifiers or desalination plants is considerable or where there is a significant water reuse.

Figure 1. Annual freshwater withdrawals in total, in billion cubic meters.[9]
Note, figure 1: For clarification, when referring to statistics of the total of freshwater withdrawal, this includes domestic use of drinking water, municipal use or supply, the use for public services, commercial establishments, homes, and water from desalination, however, it does not include the loss of water through evaporation from storage basins.

The People's Republic of China has a yearly annual freshwater withdrawal of 630,3 billion cubic meters. Thailand extract 87,1 billion, Vietnam some 71,4 billion while The Union of Myanmar withdraws 33,2 billion cubic meters. Cambodia extracts 4,1 billion and Lao PDR consume 3 billion cubic meters annually.[10] This statistics, however, only provides a picture of the total water usage of the individual countries, without taking internal resources into consideration.

Figure 2 below thus provide statistics of water usage in the individual countries when put in relation to the individual and internal resources of those countries.[11]

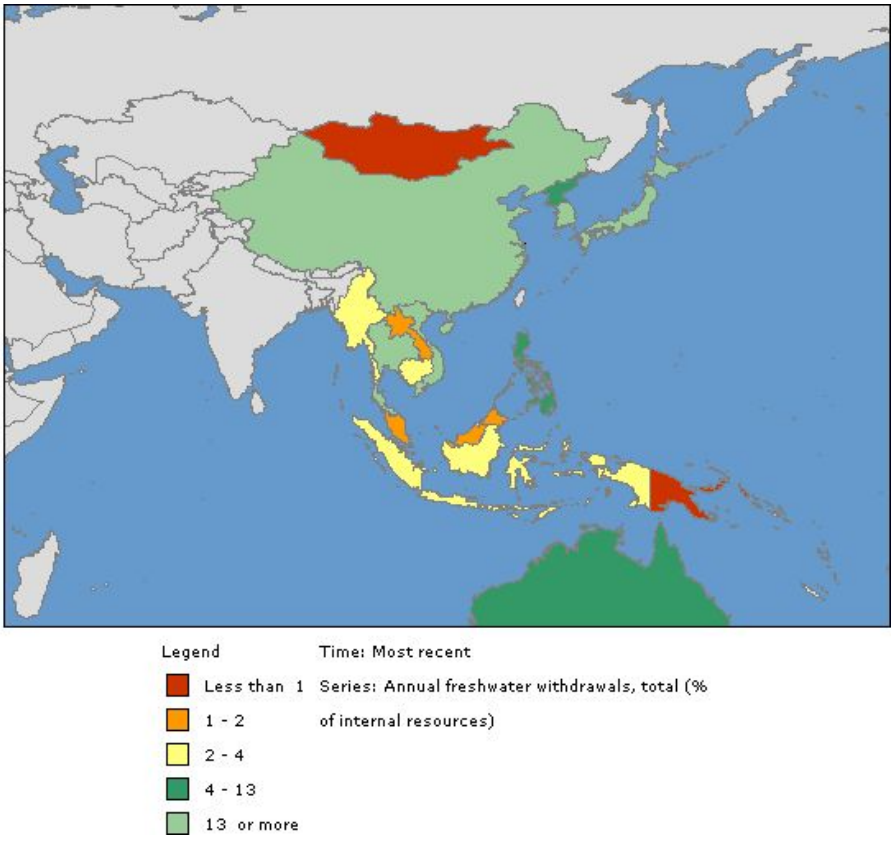


Figure 2. Annual freshwater withdrawals total, percentage of internal resources.[12]

[9] The World Bank. Most Recent Water Statistics in East Asia.
[10] Ibid.
[11] Ibid.

The figure illustrates that Thailand is statistically considerably higher on annual freshwater withdrawals in terms of internal resources with 41 percent while the People's Republic of China extracts around 22 percent. Vietnam extorts around 19 percent, the Union of Myanmar utilizes 4 percent, Cambodia 3 percent and Lao PDR around 2 percent.[13]

Water stress in the Mekong region

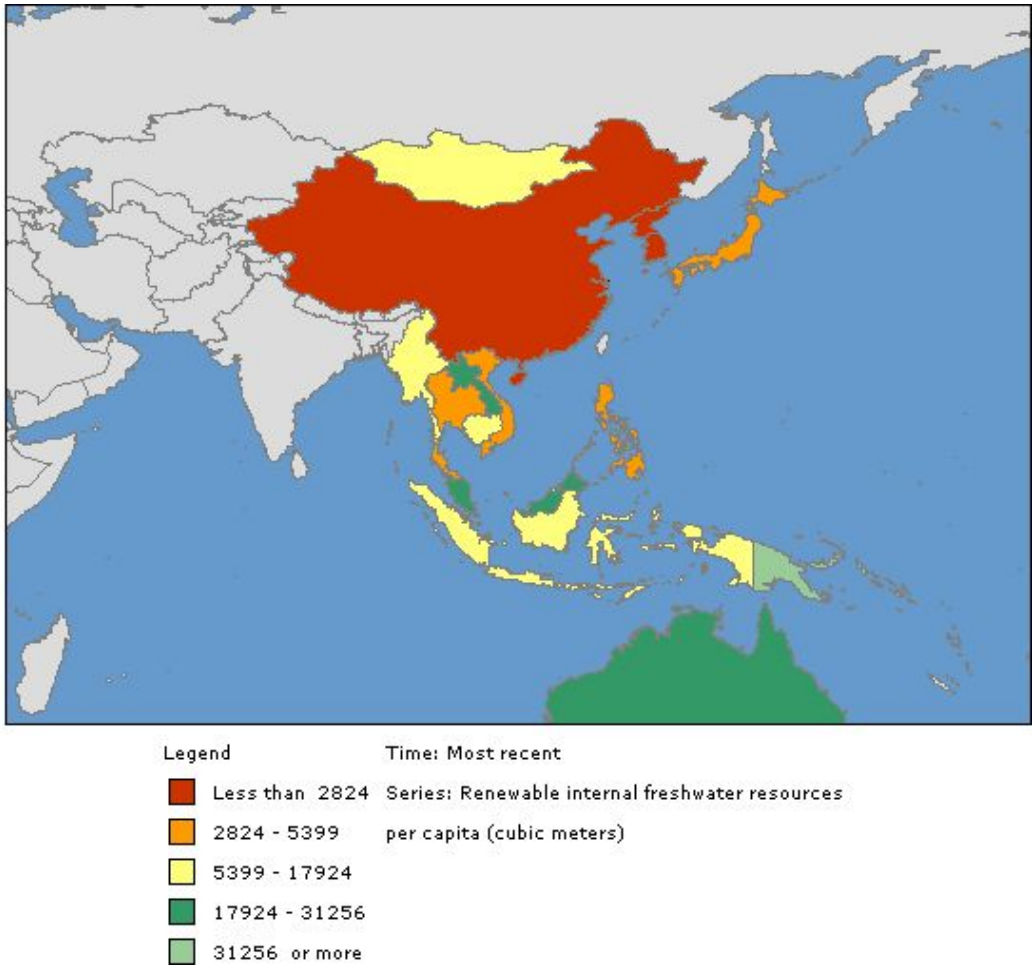


Figure 3. Renewable internal freshwater resources, in cubic meters, per capita.[14]

Keeping in mind the model used to measure water scarcity, as mentioned above, all countries of the Mekong region are above the water stress limit of 1,700 cubic meters.

[12] Ibid.
[13] Ibid.
[14] Ibid.

There is a noteworthy difference between the countries, however, which can be seen in figure 3. Lao PDR has 30,683 cubic meters of renewable freshwater resources per capita while the Union of Myanmar has 17,767 cubic meters. Cambodia has been estimated to have some 8,282 cubic meters available per capita, Vietnam 4,251, while Thailand has 3,332 renewable freshwater resources per capita accessible. The People's Republic of China has 2,124 cubic meters available per capita.[15]

Although all countries, according to this data, currently remain above the water stress limit future challenges in the shape of population growth, urbanization, changes to the water quality of the Mekong River and climate change should be taken into consideration. These threats all hold the capacity to disrupt current estimates which could exacerbate issues of water, food, human, environmental and economical security in the Mekong region. Measures to mitigate and build resilience towards these threats should therefore be undertaken immediately, in an attempt to avoid future insecurity within these societal sectors.

Lastly, it should be noted that the statistics mentioned above are provided by the World Bank in terms of data and statistics on water in East Asia and that they are somewhat inconsistent with data derived from the United Nations Environment Programme, the UNEP, in a study conducted in 2009. The UNEP study states that it is in fact the Lower Mekong Basin countries which first and foremost face water stress while the Upper Mekong River Basin is less threatened by water stress.[16] Due to this inconsistency, data transparency and regional data sharing remains a crucial concern.

Allocation of water usage

The allocation of current water resources in the Mekong region can be argued to mainly be within the agricultural sector in terms of irrigation, domestic use and the use of water resources for the industrial sector. The allocation of water resources to cover agricultural and irrigation needs again varies quite drastically between the different countries of the Mekong region. As visible in figure 4, Cambodia and the Union of

[15] Ibid.
[16] United Nations Environment Programme & Asian Institute of Technology. "Freshwater under Threat: South East Asia. 2009. p 17-18.

Myanmar allocate 98 percent of their annual freshwater withdrawals to the agricultural sector, Thailand around 95 percent while Lao PDR allocates some 90 percent and Vietnam around 68 percent.[17] No exact percentage is available for the People's Republic of China, however, it can be estimated to be between 62-74 percent of the total freshwater withdrawal, in accordance with predictions provided by the World Bank.

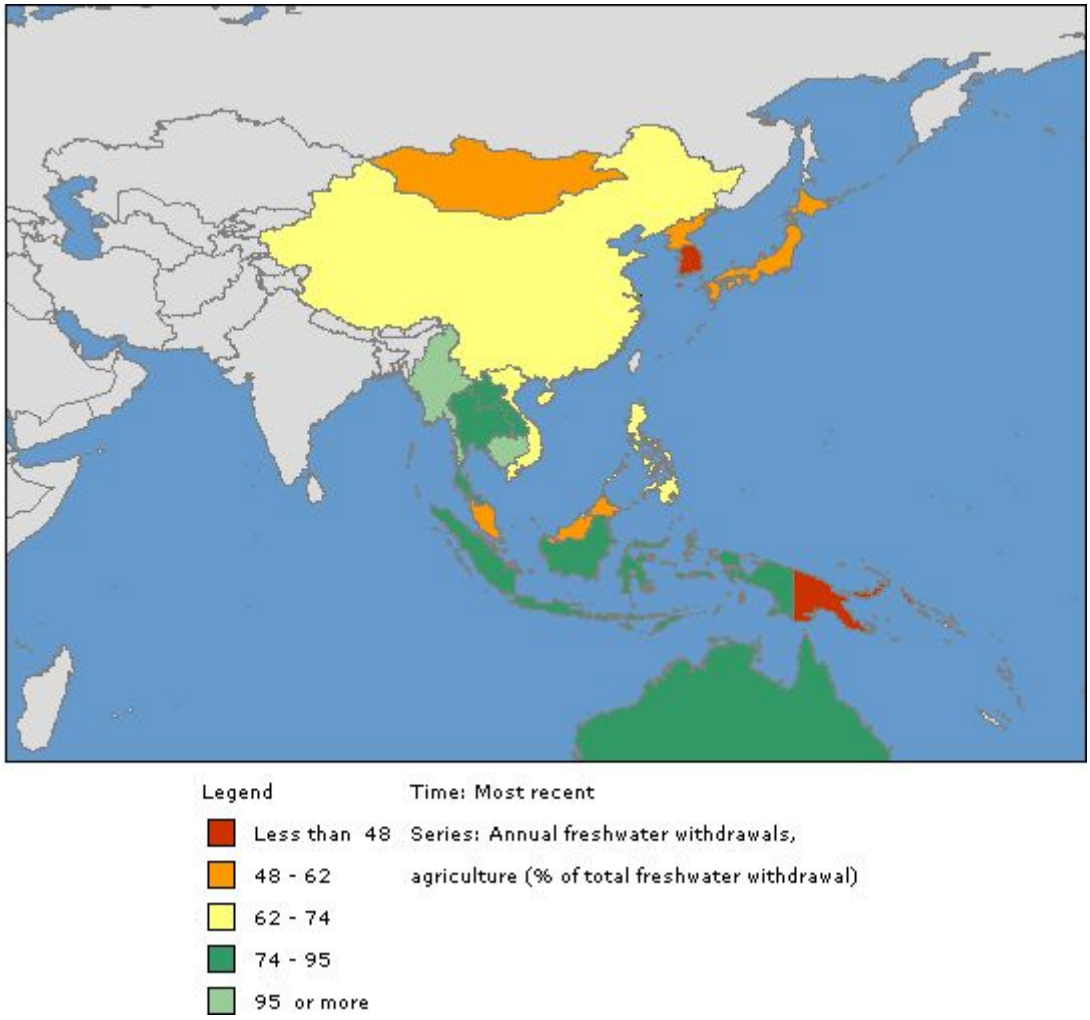


Figure 4. Annual freshwater withdrawals to the agricultural sector, in percent.[18]

Corresponding well with these figures is the statistics of domestic use of freshwater resources. Domestic use of freshwater withdrawals refers to the percentage of total withdrawals which is distributed to meet the demands of supplying drinking water, municipal use or supply, use of water for public services, commercial establishments and homes.

[17] The World Bank. Most Recent Water Statistics in East Asia.
[18] Ibid.

As visible in figure 5, Vietnam is the country in the Mekong region which allocates the most of its total annual freshwater withdrawal for domestic use at 8 percent while the People's Republic of China allocates around 7 percent for domestic use. Lao PDR is estimated to allocate around 4 percent, Thailand 2 percent and the Union of Myanmar and Cambodia distribute 1 percent of their total withdrawal.[19]

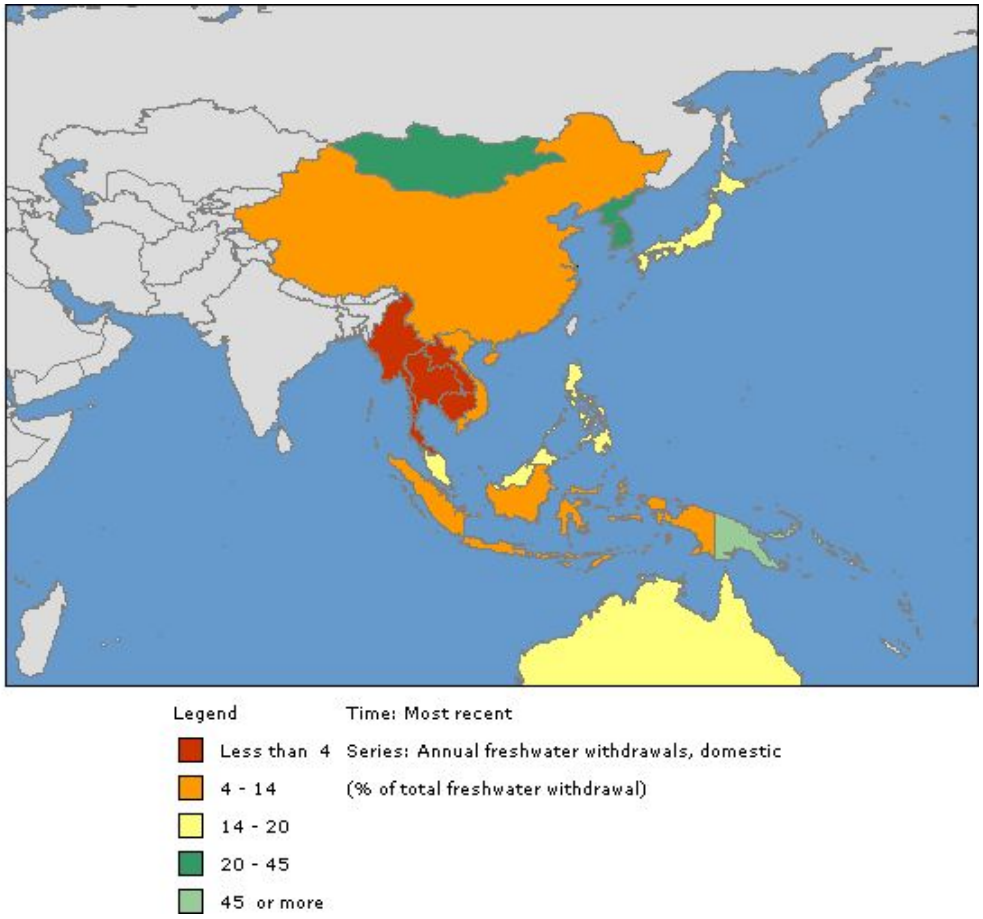


Figure 5. Annual freshwater withdrawals, percentage of total freshwater withdrawal, for domestic use.[20]

The distribution of annual freshwater withdrawals to the industrial sector refers to the allocation of water resources for direct industrial use, for example the cooling of thermoelectric plants. As can be seen in figure 6, the People's Republic of China yearly allocates some 26 percent of their total freshwater withdrawal for this use while

[19] Ibid.
[20] Ibid.

Vietnam uses around 24 percent. Lao PDR distributes 6 percent for this sector, Thailand 2 percent, the Union of Myanmar 1 percent and Cambodia 0 percent.[21]

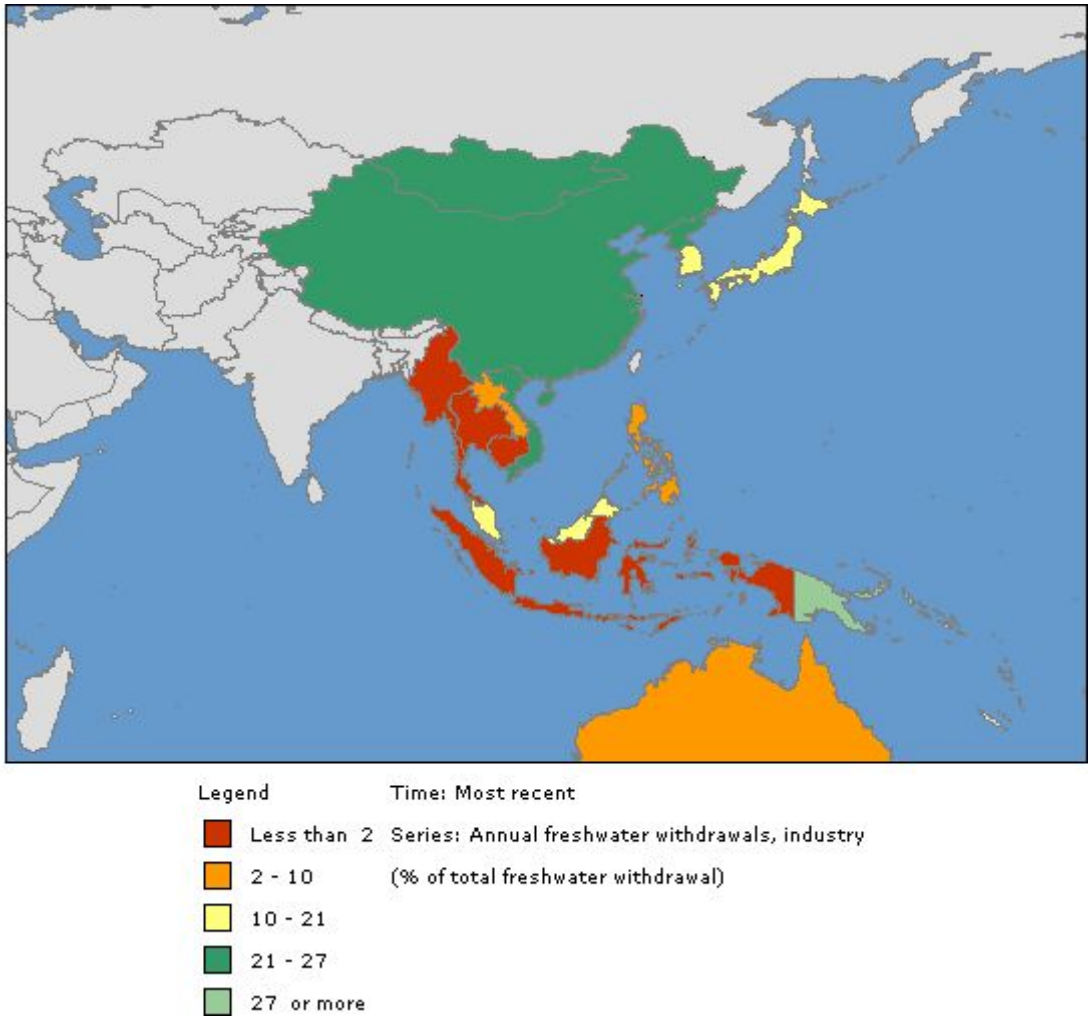


Figure 6. Annual freshwater withdrawals, percentage of total freshwater withdrawal, for the industrial sector.[22]

Using these statistics as a foundation for discussion it is clear that the management of current water resources in the Mekong region emphasizes on the allocation of water to the agricultural sector. There are still significant variations, however, and this could be explained in terms of individual country development and industrialization or modernization where the People's Republic of China, Thailand, Lao PDR and Vietnam distributes significantly less of their resources to cover agricultural needs than Cambodia and the Union of Myanmar. This is also reflected in the statistics which

[21] Ibid.
[22] Ibid.

mirror the current distribution of freshwater withdrawals to the domestic and industrial sector.

Current water management in the Mekong region

Effective water resource management is crucial from a perspective of sustainable development, economic growth and poverty reduction, and in this sense, it should be seen as a central concern to the Mekong region. As mentioned, water resources management will in this paper include the management of resources which directly or indirectly influence the water security of the Mekong region, such as for example the management of forest resources. Moreover, as this paper focus specifically on shared water resources, in the shape of water security in the Mekong region, the paper will naturally also emphasize regional cooperation, the existence of reciprocal trust and data transparency when discussing regional Southeast Asian water resources management.

Managing forest resources

The management of forest resources is indirectly linked to the management of water resources in the Mekong region as mismanagement of forest areas directly influence the soil and water quality of the Mekong River. In 1988, 50 percent of the LMB was estimated to be covered in forest, however, this number is now estimated to have fallen below 27 percent.[23] More specifically and as noticeable in figure 7, Laotian land is to 69,3 percent covered in forest, Cambodia to some 56,7 percent and the Union of Myanmar retains around 47,9 percent of its land as forest. Vietnamese land is to 43,3 percent covered in forest, Thailand to some 28,2 percent while the People's Republic of China land forest is limited to around 22 percent.

One of the main causes for a sharp decrease in forest lands in the region is the rapid deforestation and logging which has taken place. The consequences of this are numerous in number and include a contribution to changes in climatic conditions, soil

[23] Hori, Hiroshi. The Mekong: Environment and Development. The United Nations University Press: Tokyo. 2000. p 51.

erosion and the depletion of fishery resources. As an example, rapid deforestation in the north-east of Thailand is argued to have has caused a sharp increase in the occurrence and severity of flooding. In Lao and Vietnam, forests are considered to be one of the most valuable natural resources available and both countries struggle with the implementation of logging bans, in an attempt to reduce logging activity. Deforestation and logging has also caused regional displacement of populations, however, forests has also simultaneously and systematically been pushed back by an increase in population growth.

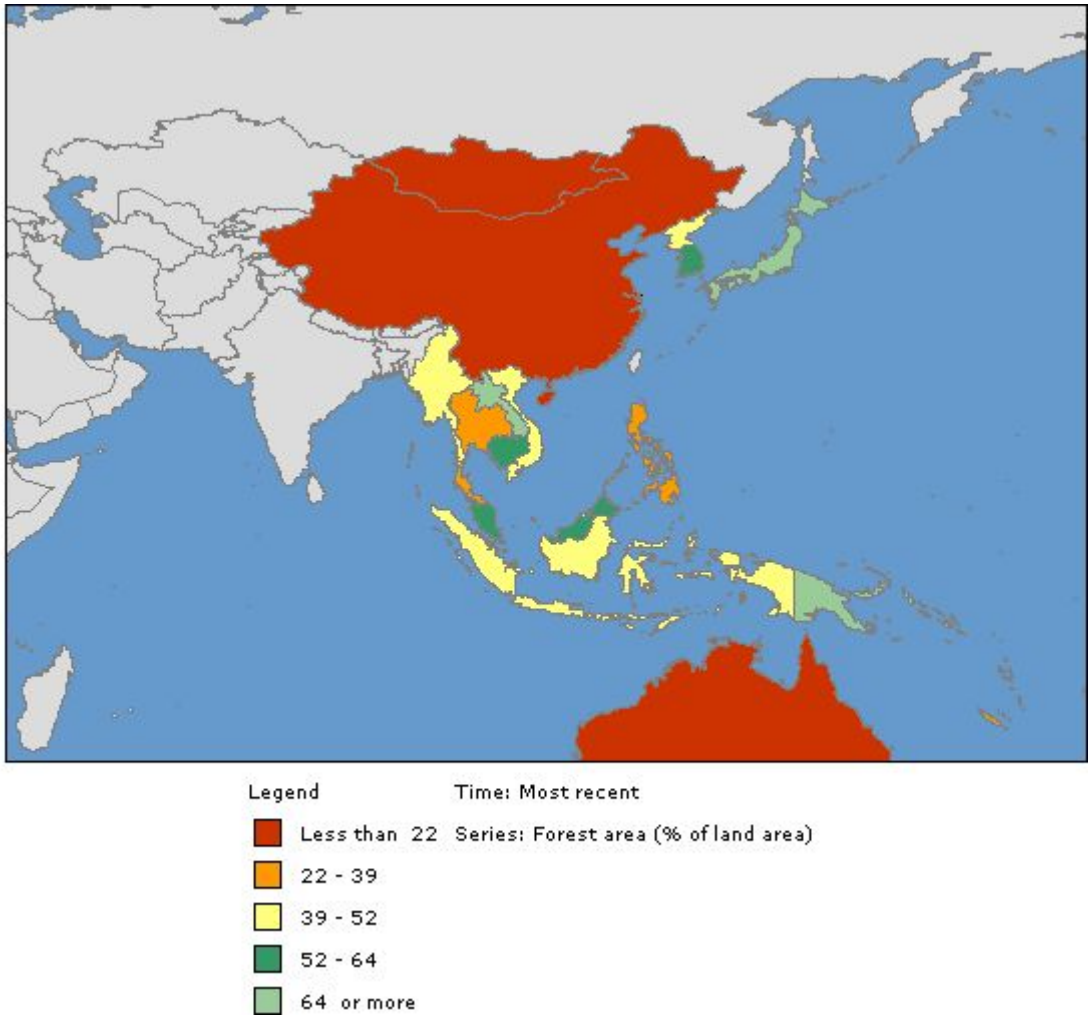


Figure 7. Forest area, in percentage, of land area.[24]

Note: When referring to forest area, this includes the area of land which contains natural or planted trees at least 5 meters in situ but excludes tree stands in agricultural production systems such as fruit plantations and also excludes trees in urban areas such as parks or gardens.

[24] The World Bank. Most Recent Water Statistics in East Asia.

The issue of deforestation in the Mekong region very much represents and symbolizes a dilemma between modernization and sustainable development. This refers to how a common concern for many of the countries in the region is how to compromise between modernization and industrialization and that of sustainable development, illustrated in the case of deforestation in Thailand, where policies have been pursued at the expense of sustainable deforestation. An underlying desire to improve standards of living by reducing poverty have in this sense been pursued while little attention has been paid to the long term consequences from a perspective of environmental, human and economical security.[25] Although pressing economic and human security concerns are difficult to ignore, deforestation needs to be carried out by while simultaneously protecting and preserving the forests. In other words; policies and legal frameworks must be developed, established and enforced to ensure a sustainable deforestation policy. This would emphasize and promote the adoption of a long-term perspective which would focus less on immediate gains from a short-term point of view.

To counter rapid deforestation, bans have been put in place in several countries in the region which heavily restricts the amount of legally exported logging. This is a positive initial step towards rectifying the issue, however, a coherent regional approach to the matter could be further developed. The potential of regional cooperation on this point is vast. For example, much illegal logging is still taking place within the countries of the Mekong region and the implementation of mechanisms which could seek to control and limit these operations are more likely to be successful if implemented on a regional level than on a national level, seeing as this is an issue shared by all countries and as the illegal activities transcends nation-state borders. As the consequences of rapid and unsustainable deforestation clearly affect the Mekong River, a comprehensive regional response to this issue would be in the interest of the entire region.

The wood industry which does exists legally also affects the management of water resources in the Mekong region. Wood industry manufacturing activities which emit pollutants have been recorded to negatively affect the water quality of the river which can be seen in figure 8. While no statistics for the People's Republic of China is available at all it is estimated that 3,3 percent of Vietnam's total Biochemical Oxygen

[25] Hirsch, Philip. "Underlying causes of Deforestation in the Mekong Region". *Australian Mekong Resource Centre, School of Geosciences.* University of Sydney. p 158.

Demands, BOD, emissions come from the wood industry, 2,4 percent for Thailand and the Union of Myanmar and less than 0 percent in Lao PDR. 14,5 percent of Cambodia's total BOD emissions are estimated to come from the wood industry.[26] Accordingly, the management of forest resources remains crucial when examining the water security of the Mekong River.

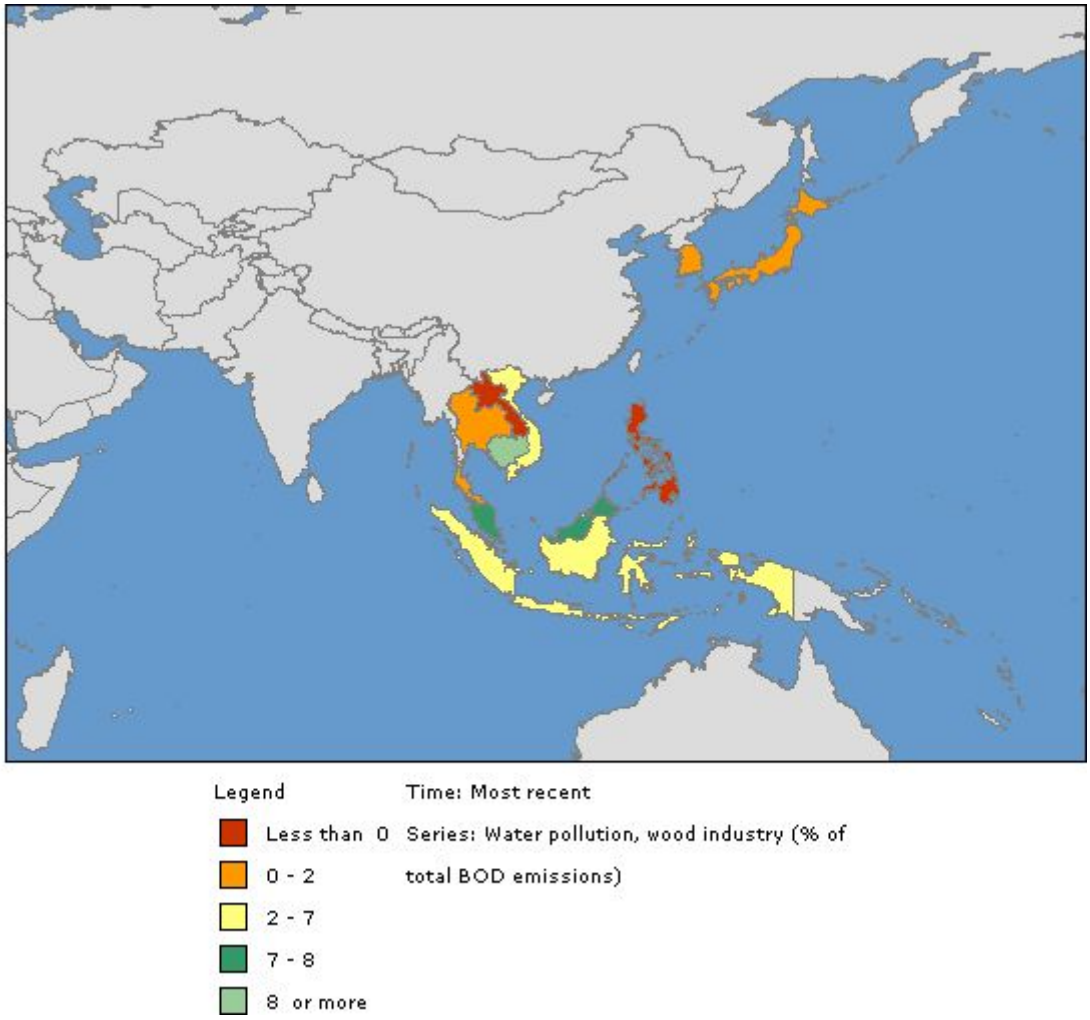


Figure 8. Water pollution from wood industry, in percent of total BOD emissions.[27]

Managing population growth

With a population annual growth rate in 2009 of 1,8 percent, Lao PDR is the country in the Mekong region with the highest growth rate. Cambodia's growth rate was estimated

[26] The World Bank. Most Recent Water Statistics in East Asia.
[27] Ibid.

in 2009 to be around 1,7 percent while Vietnam's growth rate was1,2 percent. In the Union of Myanmar the percentage was 0,9, in Thailand 0,6 and in the People's Republic of China it was 0,5 percent.[28] As the population of the countries of the Mekong region expands, much of the available resources in the region are put under increasing pressure, and water is no exception.

Population can be linked to factors which can generate water insecurity in both direct and indirect ways. It is directly linked to water security as a rapid population growth might cause the region to be unable to provide the livelihoods of the Mekong region with access to clean and safe water. Indirectly, population growth has been linked to the over-exploitation of fisheries in the Mekong River in addition to an increase in water pollution which has affected the water quality of the Mekong. The water quality, in turn, has environmental implications. Accordingly, population growth in the Mekong region should be understood as a factor which can contribute to future water scarcity.

Related to the growth of the population, the Mekong region has also experienced rapid urbanization. Accordingly, large parts of the population have migrated from rural to urban areas which in turn have caused a physical growth and expansion of cities. This has further exacerbated issues of pollution in the Mekong River. The promotion of building resilience to handle urbanization is therefore crucial in terms of providing water security in the Mekong region.

Managing climate change

The implications of climate change and its impact on oceans and geographic systems, in terms of security, has been discussed in detail.[29] The Mekong River is one such geographic system and as regional and national dependency on the Mekong River remains high, it is clear that any changes to the current situation can generate a massive transformation of the regional security. Consequently, climate change is a factor which has the potential to affect water security in the Mekong region.

[28] Ibid.
[29] For an interesting discussion of the securitization of environmental issues, please see Elliot, Lorraine. *Non-Traditional Security Issues in Southeast Asia.* Select Publishing Pte Ltd: Singapore. 2001. p 443-452.

Climate change in the form of increasing climate temperature is estimated to result in changes to the permafrost on the Tibetan plateau which in turn is expected to alter the hydrology and weather patterns of the Mekong Basin.[30] This is likely to cause an alteration in temperature, rainfall and wind.[31] In more specific terms, changes to the climate are expected to cause an increase in the overall Basin temperature of 0,79 percent which will cause an annual increase in water levels by 0.2 meters, equal to an increase of 15,3 percent.[32] As such, it is also expected to cause an increase in the severity and intensity of flooding and draught which in turn might increase the intrusion of saltwater to the Basin. In response to this, the Mekong River Commission, the MRC, has established the Flood Management and Mitigation Programme, the FMMP, which seeks to prevent, minimize and mitigate the negative effects of intensified flooding in the region. The flooding is proclaimed to increase at all parts of the basin, but with its greatest impact in downstream catchments of the Mekong.

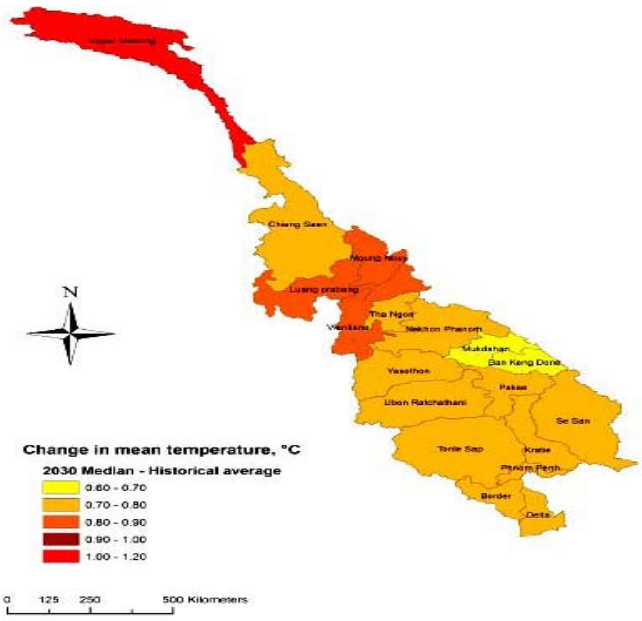


Figure 9. Geographical distribution of the projected change in mean annual temperature to 2030 compared with historical (1951-2000) figures.[33]

[30] Mekong River Commission. *Adaptation to Climate Change in the Countries of the Lower Mekong Basin: Regional Synthesis Report.* No. 24. September 2009. p xi.
[31] Ibid, p xi.
[32] Ibid, p xii.
[33] Mekong River Commission. *Annual Mekong Flood Report.* July 2009. p 8.

Changes brought about through climate change accordingly have the capacity to significantly alter the current conditions of water security in terms of the Mekong River. Further salt intrusion into the basin is also expected to change the composition of fisheries species, and as such, these changes are anticipated to disrupt the productivity in fisheries which in turn holds the potential to change conditions and patterns of economic activities which could de-stabilize the regional economic climate.

Climate change will also have severe affects on the agricultural sector. Although it has been acknowledged how regional agricultural productivity in general is expected to increase on an average by 3,6 percent, food scarcity is simultaneously expected to increase. In combination with the disruption of fisheries productivity, it becomes apparent that climate change might pose severe challenges to the fulfillment of human and food security.[34]

As mentioned, it has been acknowledged that changes in the climate most likely will increase the occurrence, duration and severity of flooding and draught, on a regional basis.[35] This can be seen in the case of Vietnam which is currently struggling to manage severe draught and shortage of water at the Ham Thuan hydro dam, which has had no water for the past months.[36] Moreover, moving beyond the obvious implications of severe flooding, such as displacement of livelihoods, it can also have large scale regional repercussions. Poor regional flooding and draught management could in this manner cause massive migration of citizens across regional borders, which can pose as a potential source of tension. It can also be seen from a perspective of economic security where the economic hardships of one nation struggling to manage flooding and draught might have spill-over affects into neighboring countries. This is tightly connected to issues if mass-migration which also could have economic repercussions as displaced citizens need to either repatriate or settle in a different country. Repatriation or re-settlement could in turn threaten the human security of migrates.[37]

[34] Ibid, p xiv.
[35] Mekong River Commission. *Adaptation to Climate Change in the Countries of the Lower Mekong Basin: Regional Synthesis Report.* No. 24. September 2009. p xi.
[36] Vietnamnet. ”Vietnam Faces Looming Water Crisis”. March 12, 2011.
[37] Harima, Reiko. Varona, Rex, DeFalco, Christina. *Social Challenges for the Mekong Region.* White Lotus: Thailand. 2003. p 245, 257.

Regional capability to manage climate change

As a part of its Climate Change and Adaptation Initiative strategy , the CCAI, the MRC has carried out research both in terms of evaluating the affects of climate change on the Mekong River but also in terms of assessing the current regional capacity to mitigate and build resilience towards changes in the climate. Focusing on Cambodia, Lao PDR, Thailand and Vietnam, the MRC has accumulated facts of how the individual countries are handling the issue, while also offering an assessment on regional capability. As climate change very much pose as a regional security threat towards water security realization, regional cooperation of this character should be encouraged, supported and developed further.

As visible in table 1, regional awareness of climate change in the general public and on an institutional level is an issue. Technical knowledge among governments and nongovernmental organizations, NGO's, is limited and analytical studies on the topic are in high demand. Due to the lack of regional analytical studies the existence of reliable climate change data is an issue. Simultaneously, adaption capability to climate change is low and a coherent regional coordination in response to climate change in developing policies is underdeveloped.

Table 1. Climate change issues in the Mekong region. Revised by author.[38]

Issue	Cambodia	Lao PDR	Thailand	Vietnam	Regional
Awareness of climate change in the general population	✓		✓	✓	✓
Awareness of climate change at different institutional levels	✓	✓	✓	✓	✓

[38] Mekong River Commission. *Adaption to Climate Change in the countries of the Lower Mekong Basin: Regional Synthesis Report.* No. 24. September 2009. p xv.

Low adaption capacity to climate change in the general population	✓				
Adaption capacity			✓		
Institutional strength and capacity			✓		
Technical knowledge among government agencies and NGO's	✓	✓	✓	✓	✓
Concrete implementation of climate change policies		✓		✓	
Perception of climate change as sector and not mainstreaming necessity	✓			✓	
Prediction and assessment tools			✓		

Climate change literature translated into local languages	✓				
Tools for advising and instructing policy makers				✓	
Analytical studies on climate change impacts	✓	✓	✓	✓	✓
Reliable climate change data	✓	✓	✓	✓	✓
Progress in implementation of NAPA/NTP	✓			✓	
Sectoral implications and adaption		✓			✓

Coordination to respond to climate change in developing policies and plans				✓	✓
Financial support for climate change initiatives	✓			✓	

✓ = An issue exists.

Accordingly, it can be argued that the regional capability to manage and counter climate change, in accordance with facts provided by the MRC, is underdeveloped. The strengthening of regional cooperation and research is thus crucial and remains central to managing water, human, food, economic and environmental insecurity, caused by climate change.

Managing the water quality of the Mekong River

Another issue which threatens the water security of the Mekong region is the increasing problem of the waning water quality of the Mekong River. As so many livelihoods daily depend on the Mekong for their survival, a decline in water quality could prove to have disastrous consequences. The water quality of the Mekong region should therefore be viewed as a regional issue as it is trans-boundary in character.

Acknowledging how a sharp increase in population, threats of pollution, migration and industrialization could affect the water quality in a negative manner, the MRC has pledged to provide technical assistance in a manner which would foster sustainable regional water resources management. Accordingly, the MRC established a Water Quality Monitoring Network (WQMN) in 1985, to continuously monitor the water quality of the Lower Mekong Basin. Three main categories were recognized to be of importance for observation: the protection of aquatic life, the human impact and the

agricultural use. The protection of aquatic life was measured by standards of high quality, good quality, moderate quality and poor quality. The human impact was in turn measured according to not impacted, slightly impacted, impacted and severely impacted. Lastly, the agricultural use was compared to standards of no restrictions, some restrictions and severe restrictions.[39]

The data, collected between 1985 and 2005 or in some cases from 2000 until 2005, deemed aquatic life to be of mostly high or good quality throughout the mainstream and the tributaries. The quality dropped for the delta part of the LMB where four stations reported aquatic life to be of moderate quality while one station reported how the quality was poor. Human impact was recorded to severely have affected the water quality in the uppermost part of the LMB and downstream at Phnom Penh. At all but one of the Mekong delta stations, the human impact was classified as severe. In the delta, the impact on agricultural use was consistently classed as severe restrictions.[40]

Pollution is stated to be one of the main causes for the changes in water quality of the Mekong River and the MRC has stated how there currently are three principal issues at hand: salinity, acidification and eutrophication. High salinities caused by saltwater intrusion are very common throughout the Mekong delta. In a similar manner, high level of sulphuric acid has been recorded, affecting the Plain of Reeds and areas in Cambodia more than others. A significant increase of total-P concentrations has also been recorded which is expected to affect the existence of algae in the river.[41]

The water quality of the Mekong River thus holds the potential to threaten the environmental security regionally, however, it can also be viewed as a security threat to the economic and human security of the region.[42] If pollution were to significantly alter the existing aquatic life of the river, this could in turn change the patterns of economic activities, as fisheries might become scarcer.[43] Although it is probable that the different countries within the Mekong region would be affected differently by this it is likely that

[39] Mekong River Commission. *An assessment of Water Quality in the Lower Mekong Basin.* No. 19. November 2008. p xiii.
[40] Ibid, p xiii.
[41] Ibid, p xiv.
[42] Mekong River Commission. *Freshwater Aquaculture in the Lower Mekong Basin.* No. 7. October 2002. p 43.
[43] Ibid, p 1.

all would be affected to some extent. The strengthening of regional cooperation, through constant monitoring and evaluation of pollution and its effects on the Mekong River, is thus crucial when seeking to safeguard regional water security.

Lastly, although there is not sufficient data suggesting that trans-boundary pollution is occurring between Lao PDR and Thailand, Lao PDR and Cambodia or Cambodia and Vietnam, some data suggest that further investigation is needed at the border of China and Lao PDR, where the human impact has been recorded as impacted. Further investigation of this issue and its implications is however needed.

Managing the construction of dams and hydropower development

With currently less than 5 percent of its catchment and water flows regulated, the Mekong River is considered to be an undeveloped resource in terms of hydropower.[44] Recently there has been an increasing interest in hydropower projects and 11 dams are planned to be constructed on the mainstream. In this sense, the construction of dams can be seen as an attempt to capitalize on the Mekong's hydropower potential in an effort to stimulate regional development, industrialization and growth.

The plans of dam construction have raised important concerns in terms of how it will influence the Mekong River, the countries who share this water resource and the livelihoods within these countries. This can be illustrated in the case of the planned dam construction at Xayaburi, in Lao PDR, where Thailand and Lao seek to construct the dam, first and foremost for energy purposes.[45] Thailand is expected to buy 95 percent of the energy generated from the dam and while Lao PDR and Thailand remain positive towards the construction, Vietnam and Cambodia have raised serious concerns of how this will affect the environment and fisheries of the region,[46] a concern which is shared and backed by Australia and the USA where representatives has recommended that the

[44] White, Ian. "Water Management in the Mekong Delta: Changes, Conflicts and Opportunities. *Technical Documents in Hydrology.* No. 61. 2002. p 8.
[45] Straits Times. "Vietnam and Laos Split over Mekong Dam". March 13, 2011.
[46] White, Ian. "Water Management in the Mekong Delta: Changes, Conflicts and Opportunities. *Technical Documents in Hydrology.* No. 61. 2002. p 8.

construction is postponed another ten years, to thoroughly assess and study how this dam will impact the Mekong River.[47]

The dams constructed in China on the Lancang in the Upper Mekong Basin, the UMB, has also raised crucial concerns of how it will affect the Lower Mekong Basin.[48] It has been recognized that dams in general and in other locations has functioned as a major catalyst for changes to freshwater ecosystems and to the environment surrounding the dam, and in this sense, dam construction should be seen as a potential threat to water security in the Mekong region, if not managed in a proper manner.[49] Regional dialogue and data sharing between the countries of the Mekong region is in this manner imperative.

As mentioned, the existence of dams is estimated to have a potential negative effect on fisheries resources.[50] In response to this, the MRC Fisheries Programme, the FP, has stated how one of its main aims is to emphasize the impact of dam construction on fisheries and how this can be taken into consideration when constructing new dams. The affects of dams on fisheries is according to the MRC divided in two categories; the modification of water flows and the affects of dam barrier and passage effects. Changes in the water flows of the Mekong is estimated to have a negative influence on the fish population by disrupting spawning behavior and success and by reducing survival and growth of fisheries due to disrupted feeding, derived from changing or unhealthy environmental conditions.[51] Barrier and passage affects are in turn imagined to hinder the migration of fisheries as they might be denied access to critical areas of the river but it is also likely to decrease the number of fisheries as survival might become an issue as they pass through dam turbines or other dam structures.[52] The development of hydropower in the shape of dam construction can in this sense threaten the food and human security of the livelihoods of the Mekong region.

[47] The Sydney Morning Herald. "Australia Urged to Help Halt Mekong Dam" March 10, 2011.
[48] Mekong River Commission. *Annual Report.* 2009. p 21.
[49] For an interesting discussion on dam building and its impact on the environment please see Hori, Hiroshi. The Mekong: Environment and Development. The United Nations University Press: Tokyo. 2000. p 212-319.
[50] Mekong River Commission. *Modelling the Cumulative Barrier and Passage Effects of Mainstream, Hydropower Dams on Migratory Fish Populations in the Lower Mekong Basin.* No. 25. December 2009. p xvii.
[51] Ibid.
[52] Ibid.

It is accordingly crucial that future dam construction is pursued with sustainability kept in mind. The need for energy should not trump the security of the regions livelihoods, and as such, the gains in relation to the costs attached with developing hydropower in the Mekong must be thoroughly assessed. It is also vital that the effects on fisheries from dam construction is continuously monitored and evaluated and studies undertaken should be promoted and supported. Interstate transparency in terms of info and data sharing is crucial and the future role of the MRC is from this perspective very important. The MRC could in this manner aim to build bridges between the individual countries, with an emphasis on regional cooperation.

In search of long term sustainable water resources usage and management

As mentioned, several countries within the Mekong region have attempted to raise standards of living and improve human and food security by implementing rapid and unsustainable policies. While awarding immediate rewards, this type of approach cannot be sustained on a long-term basis as over exploitation of these resources will, from a long term perspective, increase poverty and decrease the adaptive capability in situations of disaster, illustrated in the case of Thailand and deforestation mentioned above. Accordingly, measures to improve the immediate human or economic security should not be implemented at the expense of future water, human, food, economic and environmental security.

A framework of how to compromise between modernization and sustainable development should therefore be developed. As resource appropriation on a nation-state basis will have inevitable consequences for the region as a whole, regional dialogue and cooperation should play a key role in this process. If regional cooperation could be developed further, resources shortages can be managed and mitigated on a regional basis, which from a long term perspective would enhance the development and good governance of the entire region.

3. Water security in Cambodia

Definitions

The Cambodian context

When examining water security in Cambodia, it is crucial to view it in its societal context. Poverty is widespread in Cambodia, especially in rural areas, which firstly affects the capacity of ensuring water security for the Cambodian people. Secondly, overall poverty also affects the adaptive capability to water insecurity, leaving the population of Cambodia highly vulnerable to any negative changes to their current situation. Accordingly, the pursuit of water security should be seen from a larger perspective of good governance which also includes attention paid to the eradication of poverty.

Water security as a national security threat to Cambodia

Due to Cambodia being heavily reliant upon the Mekong River, national state security is inextricably linked to water usage and management, and the stability of Cambodia as a state can in this manner be disrupted by factors contributing to water insecurity. Moving beyond a state centric view, however, water insecurity can also generate severe threats to the economic, human and environmental security of the Cambodian people. Seeing as the livelihoods of Cambodia are highly vulnerable to any negative changes to their already strained situation, water insecurity is a crucial area of concern as it might further exacerbate water, human, food, economical and environmental insecurity.

Current state of water usage and water scarcity in Cambodia

As visible in chapter 2, Cambodia extracts 4,1 billion cubic meters of freshwater annually which constitutes 3 percent of the total withdrawals in terms of internal

resources. As it is estimated that Cambodia has 8,282 cubic meters of freshwater available per capita, Cambodia can be argued to not suffer from water stress, according to the figures provided by the World Bank. Many threats however exists which could disrupt this current situation and as adaptive capacity remains low, Cambodia can be argued to be highly vulnerable to any changes to the present situation.[53]

Current water resource allocation in Cambodia

As mentioned in chapter 2, Cambodia allocates around 98 percent of its total freshwater withdrawals to the agricultural sector. Rice is the main crop which sustains the livelihoods of Cambodia, but irrigation is also important for the cultivation of corn, green beans, cassava, kapok, sweet potatoes, pepper, sugar palms, peanuts and sesame.[54] Water resources allocation in the shape of agricultural irrigation in relation to water security is therefore crucial for the fulfillment of human and food security. Lastly, Cambodia distributes 1 percent of its total freshwater withdrawals to the domestic sector and below 0 percent is allocated to the industrial sector.[55]

Current water resource management in Cambodia

Managing forest resources

Before hostilities plagued Cambodian its land was to 70 percent covered in forest.[56] As of 2009 only 56,7 percent of forest covered land remains.[57] Much of the existing forest resources furthermore remain devastated because of previous conflicts which has left large parts unattended. Moreover, soil erosion due to miss management of forest resources, has had serious repercussions for the Tonle Sap which has become notably

[53] The World Bank. Most Recent Water Statistics in East Asia.
[54] Hori, Hiroshi. The Mekong: Environment and Development. The United Nations University Press: Tokyo. 2000. p 48.
[55] The World Bank. Most Recent Water Statistics in East Asia.
[56] Hori, Hiroshi. The Mekong: Environment and Development. The United Nations University Press: Tokyo. 2000. p 54.
[57] The World Bank. Most Recent Water Statistics in East Asia.

shallower.[58] This has already been estimated to have serious implications on fishery resources although further research is needed on the subject.

Managing population growth

Cambodia's population growth was in 2009 estimated at around 1,7 percent and is expected to rise.[59] As it does, further pressure will be put on the capacity to meet national demands for water resources. As Cambodia remains limited in its capacity to mitigate and handle population growth, especially in terms of urbanization, population growth could very much prove to pose as a serious threat to water security in Cambodia.

Managing climate change

As the predicted climate changes mentioned above are estimated to have regional implications it is clear that Cambodia will be affected by these changes. Due to the national context and setting of prevalent poverty, many countries remain highly exposed to small changes within the climate, and Cambodia is no exception. In more specific terms, climate change is estimated to increase the annual temperature in Cambodia by 0.7 to 2.7 degrees Celsius by the year of 2060 and with 1.4 to 4.3 degrees Celsius by 2090.[60] Moreover, there will be a substantial increase in the frequency of days which are considered hot while the annual average rainfall is expected to increase.[61]

As seen in table 2, climate changes are predicted to increase the agricultural productivity in the area of Northeast Cambodia, Se San, and in Central Cambodia in Kratie and the area of the Tonle Sap. The border shared between Cambodia and South Vietnam will be subject to a predicted decrease.

[58] Hori, Hiroshi. The Mekong: Environment and Development. The United Nations University Press: Tokyo. 2000. p 54.
[59] The World Bank. Most Recent Water Statistics in East Asia.
[60] Mekong River Commission. *Adaptation to Climate Change in the Countries of the Lower Mekong Basin: Regional Synthesis Report.* No. 24. September 2009. p 13.
[61] Ibid, p 13.

Table 2. Summary of predicted consequences of climate change in Cambodia. Revised by author.[62]

	Se San: Northeast Cambodia	Kratie: Central Cambodia	Tonle Sap: Central Cambodia	Phnom Penh: Southeast Cambodia	Border, Cambodia - South Viet Nam
Agricultural Productivity	+	+	+		-
Existing food Availability	- 1	- 1	- 1	- 1	- 2
Temperature	+	+	+	+	+
Annual precipitation	+	+	+	+	+
Dry season precipitation	-	-	-	-	-
Annual runoff	+	+	+	+	+
Dry season Runoff	-	-	-	+	-
Annual water Stress					

[62] Ibid, p 9.

Dry season Water stress			+		
Flooding potential	+	+	+	+	+
Peak flows		+			
Flood duration		+	+		
Flooded area		+	+	+	+
Dry season minimum flows		+			
Saline intrusion					

Note: 1= due to decrease in surplus, 2 = due to population growth, 3 = moderate level, 4 = medium level, 5 = high level, + = predicted increase, - = predicted decrease, = = staus quo, blank cell = unstated.

Simultaneously, and in accordance with predictions made on a regional level, the existing food availability will decrease in all areas within Cambodia. In the area of the Cambodian and Vietnam border, this will be due to an increase in population growth, while the other areas will be faced with a decrease in surplus. Again in accordance with regional projections, an increase in temperature will occur, which will affect all areas of Cambodia. Annual precipitation is predicted to increase while the duration of the dry season is estimated to decrease, leaving central agricultural areas vulnerable to flooding and draught.

Although the dry season is estimated to decrease, the severity of draught has been predicted to increase. An increase in draught would be a crucial future issue from a perspective of human security in Cambodia, as the Tonle Sap for example provides the Cambodian people with 70 percent of their protein intake.[63] . Changes in the current life cycle of fisheries, but also the hydrological cycle of the Mekong River, could thus have devastating repercussions from a perspective of human and food security.

As seen in table 2, estimates for annual flooding are unavailable. The potential for flooding has, however, been estimated to increase in all parts of Cambodia while the area of Kratie and Tonle Sap will be faced with an increase in the duration of flooding. As flooding however also provides Cambodia with many benefits, as it directly influences the lifecycle of fisheries, it is an important factor from an economic perspective. A problem however occurs when estimated flooding and draught increase in severity and/or duration. In Cambodia, the Mekong River has historically been observed to flood in a steady and slow manner, with a minimum amount of loss of lives.[64] This is expected to change as the temperature increases due to changes in the climate. As an example, the flood damage and losses resulting from the cyclone Ketsana in 2009 is estimated to have incurred economical costs of 132 million US$ in Cambodia, with some 8,9 million US$ spent on recovery expenses, and when seen in the context of how flooding might increase due to an increase in temperature, it is clear that this could cause catastrophic results for Cambodia as a nation.[65]

Due to the possibility of food shortage and as a part of its Initial National Communication, Cambodia has conducted a vulnerability and adaptation assessment, which examines the impacts of climate change on issues of flooding and draught, and its influence on agriculture, forestry and human security. Agricultural assessment was conducted with a focus on rice cultivation which, as mentioned above, remains Cambodia's main source of food security. Rice production loss between the years of 1996 to 2001 was estimated at 70 percent due to severe flooding. Draught caused a loss equivalent to 20 percent. The assessment also displayed how flooding and draught,

[63] Hofmann, von, Norbert. *Environmental Management and Sustainable Development in the Greater Mekong Sub-Region.* Institute of foreign affairs. Freidrich Ebert Stiftung. p 69.
[64] Ibid, p 63.
[65] Mekong River Commission. *Annual Mekong Flood Report.* July 2009. p 75.

although experienced on an annual basis, cause social and economical unrest, as adaptive capacity remains very low. Exacerbated by future climate change, flooding and draught might generate overwhelming consequences for Cambodia as a nation.

Severe flooding also introduces new issues which will need to be handled, such as health hazards. For example, as the population of Phnom Penh grows larger, the disposal of garbage and waste into the Tonle Sap is estimated to increase. When flooded, in combination with an inadequate sewage system, this pollution poses as a threat to the hygiene of the Cambodian people. The spread of disease is, as such, another repercussion from climate change which threatens human security in Cambodia.

When summarizing it is clear that Cambodia remains sensitive and vulnerable to any negative changes imposed by climate change as there is a high dependency on natural resources, such as water or fisheries, for the realization of the Cambodian livelihoods human security.[66] Absence of human security might in turn trigger economic insecurity, or vice versa, and issues of severe flooding and draught, cross-border migration, changes in patterns of economic activities, food security and changes in living environment are all issues of concern in Cambodia that are tightly connected to water security.

National capability to manage climate change

Cambodia's primary policy framework for countering climate change is the National Adaption Programme of Action to Climate Change (NAPA). The aim of NAPA has been to develop realistic policies on action and priority activities which address the need of climate change adaption. Some of the climate change hazards which are managed and targeted by NAPA is flooding, draught and salt water intrusion. Other frameworks exist but primarily focus on disaster management and relief rather than preventive measures. Accordingly, the national capacity of Cambodia to respond to climate change can be argued to be underdeveloped and relatively unable to mitigate changes to the climate.

[66] Mekong River Commission. *Biomonitoring of the Lower Mekong River and selected tributaries.* No. 13. December 2006. p 1.

Managing water quality in Cambodia

As mentioned several times, the Mekong River remains crucial for the daily survival of the Cambodian livelihoods. A decrease in the water quality of the Mekong River is thus an alarming issue from a Cambodian perspective. There is currently no functioning mechanism available which can measure water pollution exclusively in Cambodia, and as such, it is difficult to predict the exact repercussion of water pollution. Being a part of the LMB, however, some of the studies carried out by the MRC in terms of the WQMN project, cover Cambodian waters. The statistics provided by the Water Quality Monitoring Network paint a bleak picture where human impact around the area of Phnom Penh has caused the river to be severely impacted.[67] Future research is however needed to assess the situation of the water quality in Cambodia.

Managing the construction of dams and hydropower development

The negative affects which dams are likely to have upon the Mekong River has been estimated to hit the area of the LMB particularly hard.[68] While energy accordingly is needed to support the industrialization of the Mekong region, Cambodia also remains highly vulnerable to the negative repercussions which the construction of dams might inflict. As mentioned above, the construction of the Xayaburi dam has raised serious concerns in terms of possible impact on the countries of the Mekong region. If the dam would be deemed to have a negative influence on fisheries and the environment of the Mekong, it is likely that this would have a severe impact on Cambodia. The development of hydropower must therefore take factors like these into consideration so that the development of Cambodia is not further hampered.

Additionally it can be noted that the hydroelectricity generating capacity of Cambodia is stated to be more limited than its neighbors, where the northeast and southwest part of

[67] Mekong River Commission. *An Assessment of Water Quality in the Lower Mekong Basin.* No. 19. November 2008. p 26.
[68] Mekong River Commission. *Modelling the Cumulative Barrier and Passage Effects of Mainstream, Hydropower Dams on Migratory Fish Populations in the Lower Mekong Basin.* No. 25. December 2009. p 5.

the country provides the most favorable setting for dam construction.[69] Areas south of Battambang and on the rivers flowing into the Great Lake, such as Stung Chinit, also hold some potential in terms of hydropower. Most projects are, perhaps for natural reasons, aimed at supporting irrigation while power generation is considered secondary.[70]

4. Recommendations

Towards the realization of water security in Cambodia

As mentioned, Cambodia does not face immediate water stress or water scarcity. This does however not lessen the seriousness of many of the existing threats which Cambodia currently faces, and will continue to face in the near future. The national capacity to manage population growth, urbanization, forest resources, changes in the climate and a decline in the water quality of the Mekong River can be argued to be limited. This is both due to societal issues such as poverty but also due to a lack of institutional capacity in terms of functioning frameworks which can sufficiently handle current or future threats in a preventive manner, as opposed to disaster management and relief.

It can therefore be argued that Cambodia is relatively unable to adequately respond to the different forms of threats which hinder water security, and as such, it would be beneficial if support could be provided by other actors both on a bilateral and regional basis, for example through regional support from the Association of Southeast Asian Nations, ASEAN, or the MRC. Cambodia is, however, not the only country of the Mekong region which struggle to ensure water security and to mitigate driving forces which generates water insecurity within its borders. Far from all countries in the Mekong region are sufficiently equipped to manage these factors, as the analysis of

[69] Hori, Hiroshi. The Mekong: Environment and Development. The United Nations University Press: Tokyo. 2000. p 79-80.
[70] Ibid, p 79-80.

some of the security threats mentioned above suggests and emphasis on regional institutions and frameworks is therefore desirable.

While taking steps which would counter vulnerability to water insecurity on a national level, for example through the implementation of disaster management plans in Cambodia, the underlying driving factors which generate water insecurity remains. Accordingly, water security could be promoted on a national level in terms of adaption capability and security strategies in situations of distress, however, as many of the issues that Cambodia is faced with are shared regionally, a regional approach of ensuring water security would be beneficial.

Towards the realization of water security in the Mekong region

As emphasized at several occasions throughout this paper, the realization of water security in Southeast Asia, more specifically the Mekong region, remains reliant on regional cooperation, integration, data transparency and sharing, reciprocal trust between individual countries and the political will to maintain beneficial multilateral relations with one another. As illustrated in chapter 2 several issues and factors exists which currently hamper the realization of water security such as population growth, the mismanagement of forest resources, climate change and a decline in water quality within the Mekong River. As all these issues are trans-boundary in character, an exclusively individual and nation state approach to manage these issues, is insufficient.

As water insecurity in individual countries can threaten regional stability it should be in the common interest of all countries within the Mekong region to expand regional mechanisms which can handle both security threats which hinder the fulfillment of water security, such as flooding or draught, and the actual root cause for the issue, such as climate change or pollution affecting the water quality of the Mekong River. In cases of insecurity, a regional framework would also be more suited to coherently and efficiently manage the water security of the region than individual states pursuing different policies at different times.

When attempting to ensure water resources security from a regional perspective there are several actors which could provide beneficial conditions for future regional cooperation, such as ASEAN or the MRC. As regional stability and security can be seen as a raison d'être of ASEAN, its involvement could be further strengthened, for example through the ASEAN Strategic Plan of Action on Water Resources Management concerned with providing assistance to Cambodia, Lao PDR, the Union of Myanmar and Vietnam, the CLMV.[71] Actual capacity of ASEAN to aid in terms of attaining water security is a contested topic however and is at times argued to remain limited in its capability to do so.

The MRC has been fairly active in terms of monitoring various different aspects of the Mekong River with an emphasis on current and future challenges. This should be encouraged and promoted further, for example through the promotion of already existing mechanisms, such as the Basin Development Plan established in 2002. With a key focus on good governance and sustainable development, the MRC through the BDP attempts to build bridges between national line agencies, research institutions in member states, regional organizations, development partners, civil society organizations and the millions of people who depend on the Mekong River on a daily basis for their livelihood.[72]

As seen above, for example in terms of data on trans-boundary pollution, data sharing at times poses as a problem. If this were to be approached in a manner where regional benefits of transparency are emphasized and national gains and secrecy are de-emphasized, the MRC could continue to provide the Mekong region which much needed information and ideas on appropriate policy responses to looming security threats. This might in turn promote friendly and neighborly relations between the countries of the Mekong region which might generate further beneficial regional integration. In addition, it would beneficial if other actors could and would get involved in ensuring regional water security in Southeast Asian and the Mekong region, for example ASEAN dialogue partners China, Japan, Australia and the European Union, as

[71] ASEAN Strategic Plan of Action on Water Resources Management. ASEAN Secretariat. 2005. p 1.
[72] Mekong River Commission. *Stakeholder Consultation on MRC's Basin Development Plan Phase 2 (BDP2) and its Inception Report.* Consultation Proceeding. March 2008. p 7-8.

regional instability in terms of water insecurity does not only have repercussions locally but could prove to have international implications.

5. Conclusion

This paper has focused on the current water resources usage and management in Southeast Asia, with a specific focus on the Mekong region and Cambodia. The assessment has been carried out while recognizing many of the current and future challenges that the region is faced with in terms of attaining water security and managing factors which might produce water insecurity.

It can be concluded that none of the countries in the Mekong region face pressing water stress or scarcity, however, several threats such as population growth, declining water quality and climate change exists which has the potential to significantly alter the current need for potable water resources. As the current need can be projected to change, due to these factors, future water security might be jeopardized which could cause an urgent state of water stress in the region.

This article will therefore conclude by stating that water security remains a crucial and alarming issue of the Mekong region which could have devastating consequences if not managed and addressed properly. In this sense, future water resource security is an important issue which needs further attention, from a perspective of good governance and future development of the overall region.

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