International Journal of Business Analytics and Intelligence
8 (1) 2020, 53-63
http://publishingindia.com/ijbai/

Exploring Private Sector Initiatives for Adaptation to Climate Change Impacts on Water

Purba Halady Rao*

Abstract

It is now well known that climate change will have significant negative impacts on development, poverty alleviation, and the achievement of the Millennium Development Goals (MDGs) as new threats threaten water and food security, agricultural production, nutrition, and public health. Since water is the primary medium through which climate change influences the Earth's ecosystems and therefore people's livelihoods and well-being, the urgent need for all communities is to look for avenues to adapt to water-related impacts. Since Climate Change will have a significant impact on water related concerns, today's world needs to address water management issues in an urgent manner. This is especially true in developing countries. This paper explores the awareness and possibility of involving the private sector to initiatives among practicing managers in India. Using an empirical approach and applying structural equation modeling for data analysis, the paper concludes that awareness to adaptation needed in the area of disease and health, significantly leads to private sector taking up adaptation initiatives to water-related impacts of climate change. Higher the level of awareness to adaptation needed in the area of disease and health, higher will be the propensity to take up adaptation initiatives to water-related impacts of climate change.

Keywords: Climate Change, Adaptation, Water, Corporate Initiatives, Structural Equation Modelling

Introduction

The Paris Agreement on climate change, adopted in December 2015, calls for action on both the causes and consequences of the climate change. The causes of climate change are to be addressed through a drastic reduction in greenhouse gas emissions (mitigation) and its consequences are to be addressed through an equal emphasis on investment in climate resilience (adaptation) (Jain, 2011, Halady & Rao, 2010).

In 2007, a joint initiative of the United Nations Foundation and Global Leadership for Climate Action (GLCA) published a Framework for a post-2012 Agreement on Climate Change, which called for four negotiating pathways focused on mitigation, adaptation, technology, and finance. This paper focused more specifically on adaptation and its links to addressing water shortage, floods & droughts, development & poverty alleviation, need for healthcare, crop production, etc. with an emphasis on action at the local level (Asian Development Bank (ADB), 2007, 2008).

Given the far-ranging adverse impacts of climate change, adaptation must be an integral component of an effective strategy to address climate change, along with mitigation. The two are intricately linked—the more we mitigate, the less we have to adapt. However, even if substantial efforts are undertaken to reduce further greenhouse gas emissions, a large extent of impacts of climate change is unavoidable and will lead to adverse effects, some of which are already being felt. The world's poor, who have contributed the least to greenhouse gas emissions, will suffer the worst impacts of climate change and have the least capacity to adapt. Since water is the primary medium through which climate change will influence the Earth's ecosystems and therefore people's livelihoods and well-being, the urgent need for all communities is to look for avenues to adapt to water-related impacts [(The) World Bank (2003), Poverty and Climate Change: Reducing the Vulnerability of the Poor Through Adaptation, Part I, The World Bank, Washington, DC. Smit, B. & Wandel, J. (2006)].

* Visiting Faculty, Indian Institute of Management, Ahmedabad, Gujarat, India. Email: purbarao@yahoo.in

Urgency to Adapt to Climate Change Impacts on Water

Every year World Economic Forum asks about 1000 decision-makers from public sector, industry, academia, and civil society around the world to assess the risks facing the world in the decade to come. Since 2012, water crisis has been consistently ranked as one of the most important threats facing the world having the highest potential impact (Berggren, 2019). The crisis is perceived to be due to extreme weather conditions caused by climate change and other natural disasters.

Already, water-related climate change impacts are being experienced in the form of more severe and more frequent droughts and floods. Higher average temperatures and changes in precipitation and temperature extremes are projected to affect the availability of water resources through changes in rainfall distribution, soil moisture, glacier and ice/snow melt, and river and groundwater flows; these factors are expected to lead to further deterioration of water quality as well. The poor, who are the most vulnerable, are also likely to be affected the most (UN water, Climate change is mainly about water).

Under the present climate variability, water stress is already high, particularly in many developing countries, and climate change adds even more urgency for action. Without improved water resources management, the progress towards poverty reduction targets, the Millennium Development Goals, and sustainable development in all its economic, social and environmental dimensions, will be jeopardized (Rao & Thamizvanan, 2014, Sustainable Development Goals, 2016).

Recognizing that adaptation to climate change is mainly about better water management, responding to it appropriately is urgently needed in todays' world (UN water, http://www.unwater.org/). This need also presents various development opportunities, which expectedly would help communities especially in developing countries. Appropriate adaptation measures build upon known land and water management practices to foster resilience to future climate change, thereby enhancing water security (Rao & Thamizvanan, 2014). Innovative technologies and integrated solutions are needed at the appropriate scales, for adaptation as well as mitigation. Any adaptation measures, however, need to be assessed for inadvertent adverse effects, in particular on the environment and on human health (Palaksha, Nachiketas & Rao, 2017).

Literature Review on Adaptation

Among many other things, climate change threatens well-being of communities in ways that are numerous and profound. The thinking right now is strengthening developing countries' initiatives to address the impacts in whichever areas these are felt … and this is where private sector can come in (Palaksha, Nachiketas & Rao, 2017). Already, the impacts have grown to an extent much above what was forecasted (Halady & Rao, 2010; Jain, 2012). Many policies and roadmaps have been designed to address the impacts but it is ultimately up to the leaders, managers, and public at large to take it upon themselves to translate the policies into action plans, implement them in real terms, and bring about actual changes in abatement. For this to happen, leaders, managers, and the public will have to be aware of the phenomenon and its drastic implications first; this awareness would perhaps lead to a behavioral change in terms of taking up initiatives, which could address the climate change concerns (Biagini & Miller, 2013).

Building Resilience and Reducing Risk

Climate change increases risk in many different ways, particularly for those who rely on weather patterns, soils, water, and other natural resources for their livelihoods, which includes more than one billion of the world's poor. The magnitude, timing, and location of these climate impacts are inherently unpredictable (Jain, 2012; Wilk, & Wittgren, (Eds.) (2009)). Given these uncertainties, adaptation strategies should be based on interventions that will yield benefits sometimes regardless of specific, climate-related events, and sometimes on specific events. Examples of such broad win-win strategies include developing more diverse crop strains tolerant of a variety of different conditions (heat, drought, salt, etc.); bolstering social capital and resilience; increasing storage capacity for fresh water by building reservoirs or recharging aquifers; creating early warning systems and preparedness plans; improving public health infrastructure; and enhancing disease surveillance. This will be in accordance to GLCA Framework, which identified adaptation as one of the key

building blocks for a strengthened response to climate change, along with mitigation, technology, and financial resources (UNFCCC, 2008).

The following sections address adaptation in key sectors that are crucial to sustainable development: ecosystems and natural resources, food and agriculture, and health. They are closely linked; for example, the degradation of ecosystems affects water availability for agriculture and food production, thus affecting nutrition and public health. National adaptation and sustainable development plans should deal with all of these sectors in an integrated manner.

Impact Climate Change on Ecosystems and Natural Resources

Climate change will impact ecosystem changes that could result in droughts, floods, and famine. In this phenomenon, the poor will suffer the most as they are dependent on ecosystem like farmland and lack alternate employment (Mitchell & Tanner, 2006, IFC, 2010). The economies and people of many developing countries depend on ecosystem services, and their capacity to mitigate and adapt is contingent on the resilience of these ecosystems. Adaptation strategies will play a key role in strengthening the resilience of communities affected by climate change in such areas as coastal zones, agriculture, forests, water, health, and infrastructure—each of which presents its own challenges. Centers for Regional Adaptation in Agriculture, striving to develop and disseminate technologies for adaptation (for example, salt- and drought-resistant crop cultivars), should be established (Handshake, June 2011).

Unlike the wealthy, poor people often lack access to alternative services and are highly exposed to ecosystem changes that could result in droughts, floods, and famine. The poor often live in locations that are vulnerable to environmental threats, and lack financial and institutional buffers against these dangers. Climate change can lead to ecosystem failure and large-scale population displacement (Skoufias et al., 2011; Jain, 2011, Palaksha, Nachiketas & Rao, 2017).

The degradation of ecosystems disproportionately affects children and women who are increasingly playing a key role as heads of households and primary producers of food (Acosta-Michlik, L., Espaldon, V., 2008). Thus, empowering women and providing them with adequate access to education, credit, health care, and reproductive services will not only reduce their vulnerability, but also improve the well-being of their communities (World Bank, 2010; Adger, Kelly, 1999; Brookes, et al., 2010).

Impact of Climate Change on Food and Agriculture

Climate change is a serious threat to food security in many developing countries, adversely affecting food availability, access to food, stability of food supplies, and food utilization. Agriculture, affected by rising temperature, heavy downpours, and extreme heat and drought, is feared to affect food production in different parts of the world (http://www.climatechange-foodsecurity.org/). The associated heat waves, flooding, and drought have constituted a global food security emergency to communities all over. The rising temperatures and variable precipitation are likely to decrease the production of staple foods in many of the poorest regions. This will increase the prevalence of malnutrition and undernutrition, which currently cause 3.1 million deaths every year.

To address this shortfall, scientists suggest that they start with best agricultural practices, which applies to all regions, integrating the best practice for both food production and best practice to addressing climate change, leading to organic agriculture. The best form of this integration is agro-forestry (http://www.climatechange-foodsecurity.org/solutions.html).

Another very effective remedy for both emissions and food availability is changing from meat-based to plant-based diet. The single most effective and readily available fast-acting part of the solution is changing to the healthy plant diet. This, we have known for a long time, is the healthiest diet for people and our planet (http://www.climatechange-foodsecurity.org/solutions.html).

Impact of Climate Change on Health

Climate change threatens human health in ways that are numerous and profound. Many parts of the world will

experience more extreme events such as droughts, heat waves, altered exposure to infectious disease, and more frequent natural disasters that will put added strain on an already overstressed health system. For example, extreme high air temperatures contribute directly to deaths from cardiovascular and respiratory disease, particularly among elderly people. Also, most experts agree that climate change will exacerbate water scarcity and threaten agricultural productivity and global food production.

Climate change is expected to alter exposure to infectious disease in many different ways. Waterborne disease outbreaks caused by a variety of organisms are more common following extreme precipitation events, and these events are expected to become more frequent. Food poisoning events increase with higher ambient temperatures and may become more common with climate change. In addition, the distribution of vector-borne diseases, which affect nearly half the human population, is expected to change as a result of changes in temperature, humidity, and soil moisture (https://www.ipcc.ch/site/assets/uploads/2018/02/WGIIAR5-Chap20_FINAL.pdf). High temperatures also raise the levels of ozone and other pollutants in the air that exacerbate cardiovascular and respiratory disease.

Pollen and other aeroallergen levels are also higher in extreme heat. These can trigger asthma, which affects around 300 million people. Ongoing temperature increases are expected to increase this burden (https://www.who.int/en/news-room/fact-sheets/detail/climate-change-and-health).

Adaptation Needed in India on Water Impacts

In India, the major rivers get their water flow from the snow and glacier, and melt in the seasons before the summer monsoon. If this trend of temperature rise continues, the river flow in Himalayan basins may initially increase but when the reservoirs of snow and ice continue to deplete, the variability of downstream run-off will increase and water flow will subsequently reduce. This will seriously affect the livelihood of people in the river basin including fisheries and agriculture (Grail Research, 2009; Wick & Wittgen, 2009). To address many such water-related threats in India, coping mechanisms in the form of adaptation strategies are urgently needed.

In India, climate change impacts have been one of the main causes of water hazards as felt over last two decades (Water the India Story, 2009). Decreasing glaciers, sudden, unexpected floods, intense heat-waves, and long and prolonged droughts adversely impact both water quality and quantity, leading to huge scarcity of water, spread of disease both water use and water washed, mass migration in search of water, decrease in irrigation and crop production, decrease in volume of available water for use in industry and in availability of clean drinking water and for basic human hygine (Brookes et al., 2010; Halady & Rao, 2010). Because of this, India is currently viewed as being "water-stressed". Scientists warn that by 2050, India is likely to slip down the ladder to become a "water-scarce" country (Jain, 2012; Thakkar, 2010; Bhooj, 2009).

The adaptation initiatives which are expected to help in water-related impacts of climate change have been in existence in many different sectors in India. For instance, in agriculture irrigation and drainage systems have been enhanced, to bring in more water when needed and drain out excess water in flooding situations (Samui & Kamble, 2011; http://xueshu.baidu.com/usercenter/paper/show?paperid=60341ae9fd6c20f9afbfe3f77c74580a).

Also, Integrated Watershed Management has been introduced to improve agricultural productivity as well as quality. Exhaustive rainwater harvesting has been introduced in rain-fed regions; the components include Grade line Bund, Drainage Line Treatment, Ground Water recharge, etc. At the same time, Micro Irrigation techniques have been put to improve water-use efficiency. More resilient seeds, to withstand floods and droughts, have also been introduced (Ramakrishna & Rao, Water Management Water Use in Rain Fed Regions of India, CRI, file:///C:/Users/Dell/Documents/new%20research/water/water=india/water%20initiatives=%20see=India=agri.pdf).

In Forest sectors, again irrigation facilities have been improved and suitable canals have been constructed from large rivers (Deshingkar et al., 2008; http://xueshu.baidu.com/usercenter/paper/show?paperid=ac0c40e379cd74487743aacdc6ac7689).

In the areas of flood control caused by rivers and water bodies, many infrastructure initiatives have constructed in the form of embankments, dams, barrages, etc. (Jain, 2012). In the coastal zone, multiple options have been considered to overcome water-related problems. These options can protect, adapt, or relocate. We can build new projects and "climate proof" the existing infrastructure;

we can try to change our lifestyle to better live with changes; or people can be moved to other safer places (Jain, 2012).

Jain, (2012) describes adaptation measures divided into several groups, "hard" and "soft". A combination of measures usually would be most applicable. One such option, for example, is the 3R measure: recharging the groundwater; increase retention by watershed management, and reuse and recycle of water.

To enumerate some of the areas in India where adaptation will be most appropriate, either by public sector or by private, are:

Water Related Adaptation will be Related in Following Areas:

- Due to warming temperature as a result of climate change there will be higher water demands from the population,
- Due to change in hydrological cycle there be too much rain in some months (resulting in floods) and too little rain in others (resulting in droughts),
- In India more areas and hence more population will fall under severe water stress,
- Crop production will suffer due to water shortage and increasing temperature,
- Shortage in water supply will affect power generation and other industry which need large volumes of water,
- There would be increased disease and heat stress due to water shortage ,
- Mass migration in search of water will become commonplace,
- Irrigation, consuming 70% of total water need, will suffer drastically,
- Water washed diseases will increase,
- Water related diseases will increase,
- Natural habitats of water borne diseases likely to expand,
- Brackish water would affect aquaculture.

(Grail Research, 2009, Jain, 2011, Wick & Wittgen, 2009).

In many of these areas, where adaptation is required, private sector can come in a big way to help.

Involving Private Sector

Private Individuals can undertake adaptations along with or collaborating with local communities, national governments or international organizations.

In India, help required to address climate change impacts on water, is really enormous. Our country to set up the infrastructure to protect populations from floods, health-care systems to address prevalence of disease, invest in agriculture, water availability, sanitation facilities, and so on. Given this huge task involving the private sector might work, in addition to government support which is present always. Their involvement would immensely help in addressing help build the capacity for the communities affected by water-related calamities to survive the adversities caused by climate change.

Corporate managers are known to have been effective in planning and carrying out successful projects to bring about efficiency from the organizational perspective. Hence, the same effectivity can now come in to address impending climactic disaster, this time with the goal of enhancing resilience and minimizing vulnerability (http://unfccc.int/adaptation/workstreams/nairobi_work_programme/items/4623.php).

Thus, in the face of any kind of disasters and calamities, private sector can be catalyzed to help through their involvement in the wider adaptation and building up resilience of communities. The unique expertise of the private sector, leadership, its capacity to innovate and produce new technologies for adaptation, and its financial leverage can form an important part of the multi-sectoral partnership that is required between governmental, private and non-governmental actors (http://unfccc.int/adaptation/workstreams/nairobi_work_programme/items/4623.php).

In order to predict autonomous adaptations and provide an input to adaptation policies, there is a need for improved knowledge about processes involved in adaptation decisions. This knowledge includes information on steps in the process, decision rationales, handling of uncertainties, choices of adaptation types and timing, conditions that stimulate or dampen adaptation, and the consequences or performance of adaptation strategies (Burton, 1996).

So far, there is surprisingly little analysis of adaptation initiatives on the part of private sector, certainly in the peer-reviewed literature (Linnenluecke et al., 2013). A good summary of the available evidence is an OECD survey by Agrawala et al. (2011b). The authors find that most firms manage current climate risks and many are aware of future climate change. However, few firms consciously engage in adaptation to climate change. Instead, climate risks are addressed under different areas such as business continuity planning and supply chain management (Biagini & Miller, 2013).

In relation to the areas where adaptation will be required, following strategies on behalf of private sector, may be implemented (Moss et al., 2003; WBCSD, 2005, 2007).

Possible Adaptation Strategies for Industry

Private sector options to climate change adaptation relating to water.

Adaptation to Reduce Water Demand in the Face of Shortage

In the face of water shortage, private sector can help in :

- Industry Investment in recycling and treatment of industrial wastewater,
- To reduce water demand,
- Incorporate efficient water usage practices,
- Promote conservation of water,
- Practice rain-water harvesting
- Invest in waste water treatment plants to reduce water demand,
- Start incorporating 3R: reduce, reuse, recycle ,
- Incorporate sewage water management and recycling,
- Start monitoring of water consumption,
- Promote Optimization of operations such as cooling tower operations.

Adaptation to Help Communities have Access to Water

Under the title Adaptation to Help Communities have Access to Water, the paragraph can be changed to:

Industry can help in

- Providing irrigation water and increase agricultural production,
- Incorporate community based Watershed development,
- Set up drinking water and purification systems,
- Develop community water management to reduce water demand,
- Promote Water conservation equipment,
- Set up used water cleaning and recirculation systems,
- Incorporate program for thermal stations to reduce usage,
- Help farmers halt watershed erosion and grow more food,
- Improving infrastructure and sanitation facilities in neighboring residential areas,
- Improving sanitation and availability of drinking water in communities,
- Promoting waste-water treatment plants for groups of small companies.

Raising Awareness for Water Conservation for Communities

Holding awareness seminars for water conservation for schools Holding awareness seminars on water conservation for employees Optimization of processes to reduce water Striving to make the industry 0-water demand industry.

Adaptation Strategies to Address Healthcare Impacts

Climate Change is a global issue having impacts in varied different areas. One such affected area is health sector where climate change has had severe impacts. Many health hazards are caused by water-borne, water-washed, and other diseases caused by water-related problems, shortage, and lack of clean water. These can be addressed by extensive healthcare facilities which should be made available to affected communities (Bhooj, 2009).

The initiatives which the private sector can take up may emerge in different formats … in the form of corporate social responsibility, in the form of PPPs, Public Private Partnerships, or as their own Outreach Programs.

To assess the awareness of private sector to different areas where adaptation is needed in India, we considered an empirical research using a database which was generated with the use of a survey. The database was used to explore the extent of awareness to :

- Adaptation needed in addressing higher water demand,
- Addressing change in hydrological cycle resulting in floods and droughts,
- Existence of water stress,
- Crop production suffering due to water shortage and higher temperature,

- Industry operations suffering due to water shortage,
- Mass migration in search of water,
- Irrigation needed urgently due to shortage of water, and
- Prevalence of water-washed diseases, water Bourne diseases, water related diseases and diseases caused by water stress.

The Research Question

This research was conducted with the objectives:

- To assess the awareness of private sector to different areas where adaptation related to water is needed in India, and
- To assess if the awareness would indeed inspire the private sector to take up the initiative to help in the adaptation to climate change impacts on water.
- To address the research question, the empirical research was conducted using database which was generated with the use of a survey. Three different areas where awareness to adaptation needs were required were:
  - Awareness to adaptation needed in the area of ecosystem and natural resources.
  - Awareness to adaptation needed in the area of food and agriculture.
  - Awareness to adaptation needed in the area of disease and health.

Empirical Research

In the empirical research, the researchers explored to assess the awareness of corporate managers on adaptation areas which needed their involvement and attention, such as described above. The research was implemented on a population of Indian managers working in different organizations in the private sector. The research instrument was a questionnaire, which measured awareness to constructs as detailed below. The data collection was non-probability sampling. The questionnaire was digitalized and the link was sent to a population of middle managers at different levels in the country. The final sample size was 166.

The questionnaire essentially sought awareness from Indian managers in the private sector on a 4-point Likert Scale on adaptation areas which need addressing, such as given above. The 4-point scale on awareness was: NA = Not aware, LA = Little aware, A = Aware, VA = Very aware.

Construct 1: Awareness to Adaptation Needed in the Area of Ecosystem and Natural Resources in Eater Context

Floods and droughts
Water stress: shortage drinking water
Water shortage for community demand because of shortage
Water shortage for industry demand for water due to shortage
Heat stress due to warming oceans

Construct 2: Awareness to Water-Related Adaptation Needed in the Area of Food and Agriculture

Impact on crop production suffer
Irrigation needed urgently
Food storage suffering
Fisheries depleting

Construct 3: Awareness to Adaptation Needed in the Area of Disease and Health in Water Context

Water-wash disease
Water-related disease
Waterborne disease

Construct 4: Adaptation Initiatives to Address Water Impacts

How keen are you to take up water-related initiatives in the CSR (Corporate Social Responsibility) format.
How keen the respondent would be to work towards providing clean water to surrounding communities, etc.

In addition, questions were asked relating to demographic features such as age and income of respondent, number of years of operation in the company the respondent is working for, were asked.

In the last part of the questionnaire, a question on if the respondent is interested to incorporate the adaptation initiative in the organization, was asked. This was on a binary scale, zero or one, Yes or No. This could be on individual initiative or acting as change agent to inspire the organization to take up the cause. Further a question on how keen the respondent would be to take up water-related initiatives in the CSR (Corporate Social Responsibility) format and another question on how keen the respondent would be to work towards providing clean water to surrounding communities, were asked. These last two questions were on a 4-point scale: (Not Keen, Little Keen, Keen and Very Keen). These three questions constituted the fourth construct.

The first three constructs were taken as independent variables and the fourth construct as a dependent variable. These constructs constituted the research model to be validated in the data analysis. In addition to three constructs which were used as independent variables, two other independent variables were also considered which were years of operation of the company the respondent is working for, and income level of the respondent. For data analysis, structural equation modeling (SEM) approach was considered.

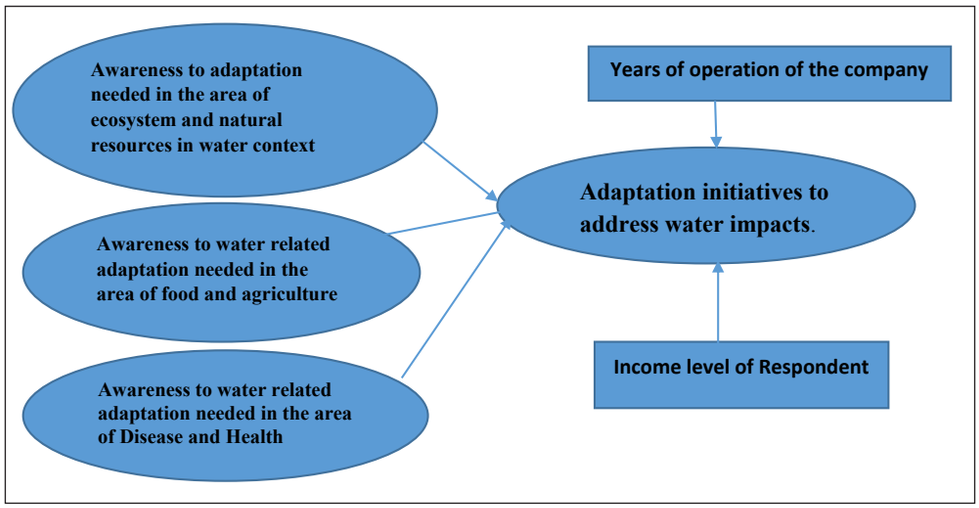

Fig. 1: Research Framework/Model used in the Structural Equation Modeling Approach

Data Analysis by Structural Equation Modeling (SEM) Approach

In the SEM approach, first the construct reliability was assessed for each construct by looking at the levels of Cronbach's Alpha.

Assessing Construct Validity using Cronbach's Alpha

For each of the four constructs, the Cronbach's alpha values were computed as given below (Table 1).

Table 1

Construct	*Cronbach's Alpha*
(1) Awareness to adaptation needed in the area of ecosystem and natural resources	0.776
(2) Awareness to adaptation needed in the area of food and agriculture	0.772
(3) Awareness to adaptation needed in the area of disease and health	0.922
(4) Adaptation initiatives to address water impacts	0.815

The Cronbach's alpha values were highly acceptable assuring the construct validity for all constructs used in the model.

The entire model, as given in Fig. 1, was run several times to arrive at acceptable fit indicators.

The final model had the following Indicators:

Chi-square/degrees of freedom	1.152 (good fit)
Overall model p-value	0.138 (good fit)
Root mean square	0.046 (good fit)
CFI	0.982 (good fit)
GFI	0.887 (acceptable fit)
AGFI	0.834 (acceptable fit)
NFI	0.884 (not acceptable) etc.

Looking at the most important indicators, Chi-square/degrees of freedom (which should be < 2) and overall model p-value (which should be > 0.05), the final model was accepted.

The regression weights and their significances for the structural model were:

Table 2

			Regression Weight	*SE*	*Critical Ratio*	*Significance*
Adaptation food	<---	Adaptation ecosystem	1.131	.196	5.765	***
Adaptation health	<---	Adaptation ecosystem	1.090	.191	5.692	***
Adaptation health	<---	no years	.110	.047	2.348	.019
Adaptation initiative	<---	Adaptation ecosystem	-5.341	33.094	-.161	.872
Adaptation initiative	<---	Adaptation food	5.377	29.454	.183	.855
Adaptation initiative	<---	Adaptation health	.122	.059	2.067	.037
Adaptation initiative	<---	income	.188	.081	2.324	.020
Adaptation initiative	<---	no years	.049	.079	.619	.536

In the Table 2, the significant links were identified as having critical ratio > 1.96 and having individual p-value significance as < 0.05.

Hence, the significant links to adaptation initiatives to address water impacts, are:

- Awareness to adaptation needed in the area of disease and health → Adaptation initiatives to address water impacts,
- Income level of respondent → Adaptation initiatives to address water impacts.

There are three other significant links but not to the dependent variable. These are:

- Awareness to adaptation needed in the area of ecosystem and natural resources leading to awareness to adaptation needed in the area of food and agriculture.
- Awareness to adaptation needed in the area of ecosystem ad natural resources, leading to awareness to adaptation needed in the area of disease and health.
- Years of operation of the company leading to awareness to adaptation needed in the area of disease and health.

Looking at the significant links (1) and (2), one observes that data supports the hypothesis that awareness to adaptation needed in the area of disease and health significantly leads to private sector taking up adaptation initiatives to water-related impacts of climate change. Higher the level of awareness to adaptation needed in area of disease and health, higher will be the propensity to take up adaptation initiatives to water related impacts of climate change. So, we have to raise the awareness of senior managers, higher up in income level to adaptation needs in the area of disease and health.

Further, the managers (respondents) who are higher up in income level have greater propensity to take up such initiatives.

Discussion of Results

As discussed earlier, climate change is one of the greatest challenges of our time. IPCC report 2007 has reported that India will have to face much higher temperatures, frequently occurring heat waves, extreme precipitation, frequent drought, and melting and disappearance of glaciers. The Himalayan glaciers may reduce in size from 500,000 sq. km to 100,000 sq. km by 2030. This receding glaciers will have severe adverse impact on the hydrological system and water resources of the country. Retreating glaciers would also bring about increase in flood frequency and landslides in the Himalayan foothills. It is feared that the per capita availability of water will shrink from about 1,800 cubic m to 1,000 cubic m, making India a water-scarce country and affecting agricultural productivity by around 30%. Going by global norms, India is currently viewed as being "water-stressed". Scientists warn that by 2050 India is likely to slip down the ladder to become a "water-scarce" country (Boojh, 2-9).

This would cause the risk of epidemics due to vector-borne diseases to increase. The sea level rise will have potential impacts in human health in terms of death and injury due to flooding, reduced availability of fresh water due to saltwater intrusion, and contamination of water supply through pollutants from submerged waste dumps. It will also cause a loss in agricultural land, changes in fish catch and a change in the distribution of disease-spreading insects. This would give rise to adverse effects on health and loss of nutrition in food available to masses due to uncertain and unknown effects on food production.

To address these impacts of climate change, our research brings out that the awareness of private sector in these areas of adaptation needed in disease and health would directly and significantly increase the propensity of private sector to take up the adaptation initiatives. In another research (Halady & Rao, 2010), it has been observed that awareness of impact on health is the most important factor which triggers individual initiative on the part of private sector to taking up the cause in promoting sustainability. So, the current research corroborates the earlier research (Halady & Rao, 2010) on the adaptation to water-related initiative on the part of private sector.

In India, already many private sector companies have come forward to voluntarily take up adaptation in water-related impacts (CII 2009). These have been in rain-water harvesting, community/rural drinking water; defluoridization; salinity mitigation for daily water use, etc. All the same, much more involvement of the private sector will be welcome and the purpose of this research is to campaign, promote, and motivate other industries to replicate these efforts and renovate and innovate the present practices to take them to the next level of perfection (CII 2009).

References

Acosta-Michlik, L., Kelkar, U., & Sharma, U. (2008). A critical overview: local evidence on vulnerabilities and adaptations to global environmental change in developing countries. *Global Environmental Change, 18*(4), 539-542.

Adger, W. N., Dessai, S., Goulden, M., Hulme, M., Lorenzoni, I., Nelson, D. R., Naess, L. O., Wolf, J., & Wreford, A. (2009). Are there social limits to adaptation to climate change? *Climatic Change, 93*(3-4), 335-354.

Adger, W. N., & Kelly, P. M. (1999). Social vulnerability to climate change and the architecture of entitlements. *Mitigation and Adaptation Strategies for Global Change, 4*(3).

Brookes, J. D., Ainger, C. M., Howe, C., Norton, J. W., & Schladow, G. (2010). Water and climate change: Challenges for the 21st century. *Journal of Water and Climate Change, 1*(1), 1.

Burton, I. (2009). Climate change and the adaptation deficit. In L. Schipper and I. Burton, (Eds.). *The Earthscan Reader on Adaptation to Climate Change.* London: Earthscan.

Boojh, R. (2009). *Environment and health issues related to climate change.* National Symposium on Environmental Threat to Human Health in 21st Century, MMV, Banaras Hindu University. January 16-17, 2009.

Deshingkar, P., Sharma, P., Kumar, S., Akter, S., & Farrington, J. (2008). Circular migration in Madhya Pradesh: Changing patterns and social protection needs. *The European Journal of Development Research, 20*(4), 612-628.

Biagini, B., & Miller, A. (2013). Engaging the private sector in adaptation to climate change in developing countries: Importance, status and challenges. *Climate and Development, 5*(3), 242-252.

Berggren, J. (2019). 9 out of 10 worst global risks are linked to water. Retrieved from https://www.siwi.org/staff-member/mr-jens-berggren/https://

Grail Research. (2009). *Water, the India Story*. http://www.grailresearch.com/pdf/ ContenPodsPdf/Water-The_India_Story.pdf. accessed on October 12, 2017

CII. (2009). *Breaking the boundaries in water management - A case study booklet.* Water Institute, Jaipur.

Halady, I., & Rao, P. (2010). Can awareness to climate change lead to behavior change? *International Journal of Climate Change, Strategies and Management*, *2*(1), 6-22.

Jain, S. K. (2011). Sustainable water management in India considering likely climate and other changes. *Current Science*, *102*(2), 25.

Kulkarni, H., & Thakkar, H. (2012). Framework for India's strategic water resource management under a changing climate. Chapter In *Handbook of Climate Change and India: Development, Politics and Governance,* Oxford University Press, Delhi.

Mitchell, T., & Aalst, M. K. V. (2008). *Convergence of disaster risk reduction and climate change adaptation: A review for DFID.* Department for International Development (DFID), London, UK.

Mitchell, T., & Tanner, T. (2006). *Adapting to climate change challenges and opportunities for the development community* (pp. 5-36). Institute of Development Studies, Tear Fund.

Moss, B., Mckee, D., & Atkinson, D. (2003). How important is climate? Effects of warming, nutrient addition and fish on phytoplankton on shallow lake microcosms. *Journal of Applied Ecology, 40,* 782-792.

Palaksha, C., Nachiketas, N., & Rao, P. (2017). Industry initiatives to addressing water concerns in India

today: The inward and the outward looking possibilities. *International Journal of Business Ethics in Developing Economies, 6*(1), 1-9.

Samui, R. P., & Kamble, M.V. (2011). Climate change adaptation and mitigation for drought prone areas in India. In book: *Challenges and Opportunities in Agrometeorology* (pp. 335-353).

Skoufias, E., Essama-Nssah, B., & Katayama, R. (2011). Too little, too late: Welfare impacts of rainfall shocks in rural Indonesia. Policy Research Working Paper 5615. The World Bank, Washington, D.C.

Thakkar, H. (2010). India's tryst with the big irrigation projects. Retrieved from http://www.sandrp.in/irrigation/Failure_of_ Big_Irrigation_Projects_and_Rainfed_Agriculture_0510.pdf

Wilk, J., & Wittgren, H. B. (eds.) (2009). Adapting water management to climate change (Swedish Water House Policy Brief No. 7). Stockholm: Stockholm International Water Institute. Retrieved November 2012, from http://www.siwi.org/documents/Resources/Policy_Briefs/ WHWaterClimate.pdf