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Global Sustainability Risk to India

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Abstract

Global economic risk management extends beyond India's borders and will have severe impact if not properly addressed. According to the World Economic Forum (2016), "A global risk is an uncertain event or condition that, if it occurs, can cause significant negative impact for several countries or industries within the next ten years." These risks include: ageing population, climate change, polarization of societies, rise of chronic diseases, rise of cyber dependency, rising geographic mobility, wealth disparity, shifts in power, and urbanization (World Economic Forum, 2016). This paper focuses on two primary sectors of the Indian economy: agriculture and water. In addition, discussions around the positive and negative aspects of global economic risks from natural disasters and the ways in which these risks have been accepted, avoided, mitigated or transferred in India. In conclusion, the paper presents a forecasting model on what to expect in these sectors over the next decade.

Keywords: agricultural, water security, pollution and waste management, economics, earth systems

1. Introduction

Global risk covers a wide range of areas, from the risk of worldwide climate change, loss of ecosystems, major natural catastrophes, and man-made environmental catastrophes.

Certain parts of the world and cultures are more vulnerable to certain global risks, while many of them affect the entire world and all of humanity. For instance, state collapse, governmental crisis, or large scale terror attacks are likely to occur in Africa, and man-made environmental catastrophes are likely in Eastern Europe, China, and India (World Economic Forum, 2016, pp. 28-34). A food crisis would more likely occur in Africa and South America, whereas a fiscal crisis, high unemployment and other fiscal crises would likely occur in North America and Europe. These predominant risks are addressed to demonstrate the interconnections between nations and global risks.

The Global Challenges Foundation (2016) further defines Global Catastrophic Risks (GCRs) (The Global Priorities Project, 2016), as those threats that have the potential to eliminate at least 10% of the global population. There are now a wide-range of global risks pertaining to climate change, environmental destruction, international terrorism, cyber terrorism, and the ever-present possibility of natural catastrophes causing a threat to health, technology, and trade in developing countries like India.

There are a variety of natural and man-made materials that cause a great slowing or even extinction of numerous species by the ejection of large amounts of "...smoke, dust, and/or sulfates into the stratosphere [where] they could cause global cooling, sunlight loss, ozone loss, and subsequent agricultural disruption." (Barratt et al., 2016, p. 81) These same influences, among others, directly affect life-sustaining agricultural output and availability of fresh water.

According to the Indian Brand Equity Foundation (2016) India's agricultural sector, water sector and its service sector are all strategic locomotives to the continuous development of the Indian nation (IBEF, 2016). Risks have been identified within each of these sectors that if not managed, may cause future disruption to the economic growth of India.

1.1 Agricultural Sector

India's economic performance post reform has many positive and negative trends across sectors. While recent policies focus on industry and trade, one key feature observed in India's development has been the contribution of agriculture. Soon after gaining Independence from the British in 1947, Jawaharlal Nehru remarked: "everything else can wait, but not agriculture." (Loebenstein & Thottappilly, 2006) Over the years India has gained international acceptance as one of the leading exporters of commodities such as rice, wheat and other clusters of

raw materials for other major agro-industries. India's geography is unique because it provides many favorable agricultural conditions, such as plain areas, fertile soils, long growing seasons, and wide variations in climatic conditions. India also has the second largest viable agricultural landmass worldwide, with 157.35 million hectares (Kaul, 2015).

According to the 2011 Census Info for India, the Indian population was tracked at 1,210,854,977, of that, the rural population consisted of 833,748,852, equivalent to roughly two thirds of the economy relying heavily on agriculture. In India over 70% of the population depends on agriculture as their main source of income (Thenmozhi & Thilagavathi, 2014). India has one of the largest economies in the world; in terms of nominal GDP, India ranked seventh with a total of $2,250.990 billion (Statistics Times, 2016). Agriculture contributed approximately 18% to the GDP of the Indian economy (Thenmozhi & Thilagavathi, 2014).

India has one of the largest plain areas of the world in the form of Indo-Ganga Plain and on social and economic terms is the most important region in India. This plain stretches from the Indus River system in Pakistan to the Punjab Plain, and the Haryana Plain to the delta of the Ganga (or Ganges) in Bangladesh. The Indo-Gangetic (IGB) Basin, is one of the world's most populous, home to the people of the Indus Valley, one of the earliest civilizations in the world (Sharma, 2008). The IGB system drains waters from the southern Himalayan and the Hindu Kush (Water Tower) Asia, these waters carry silt and other valuable resources that are useful for crop irrigation. The Indo-Ganga Plain is an economic base for agriculture, forestry, fisheries, livestock, plus urban and industrial water requirements for approximately one billion people (Sharma, 2008).

Aside from its favorable geographic location, India receives favorable amounts of rainfall, a necessary component for reliable agricultural production. The majority of India's population depends on cereal and pulse production for sustenance. Rainfall occurring over India during summer monsoon season (the major rainy season generally starts in June and ends in September) significantly affects the agricultural production of the country by providing water for the two-main crop growing seasons, Kharif (summer) and Rabi (winter). Recent studies done by India's Ministry of Agriculture Statistics show that 75% of India's annual rainfall comes from the monsoon season, which highlights the uniqueness of India's climatic contributions to its agriculture (EANDS, 2015).

1.1.1 Trade in Agriculture

India is the second top producer of rice and wheat in the world, contributing heavily to global trade, and is overall the seventh largest exporter of agricultural goods. As of 2013, Indian agricultural exports reached $39 billion, a $34 billion increase from 10 years earlier in 2003 (USDA, 2014). Ultimately, the effects of a global crisis on agriculture trade, will in turn affect the Indian market. In particular, agricultural exports accounted for 10% of India's total exports, which included spices, rice and wheat, and fruits (IBEF, 2016). Minimum support prices (MSP), of rice and wheat are bought by the Indian government from Indian farmers. The increase in the MSPs has led to a surge in government stocks and a greater development in production. The growth in government expenditures on rice and wheat contributed to the amount of exports from India (USDA, 2014). Government support has allowed for exports of grains to increase by issuing stocks into the domestic market, allowing for Indian commodities to become more competitive through lower prices (USDA, 2014).

1.1.2 Risks in Agricultural Trade

India's role in the global market is significant, primarily for rice, exporting $7.1 billion since 2013 (USDA, 2014). According to data from the Agricultural and Processed Food Product and Export Development Authority (2016), Basmati rice, buffalo meat, grape and wine, dehydrated onions, garlic and clusters of other commodities are the leading exports identified to sustaining growth in India's food product exports. These commodities are mainly found in Haryana, Punjab, western Uttar Pradesh, and regions of Maharashtra.

Research indicates looming risks associated with trade that may negatively influence the Indian economy. Chakrabarty's Climate Change and Food Security in India (2016), clearly delineates that some of the chief risks to trade include shortages in agricultural supplies, climate change, and scarcity of resources. Because of India's reliance on agricultural exports, it is vital to consider the threats and possible solutions that might lead to continued agricultural production levels for the Indian economy.

1.1.3 Climate Change and Its Effects

Another significant aspect of agricultural growth depends on the environment. Climate change in India has its own effects on the production of agriculture. Global radiation of long-lived greenhouse gases (LLGHGs) and short-lived climate pollutants (SLCPs) are the outcomes of anthropogenic climate changes in India, which has a negative impact on the cultivation of agricultural products (Burney & Ramanathan, 2014). The Ministry of Environment and Forests (2007) produced a statement about the greenhouse gases admitted into the Indian

environment:

> The agriculture sector emitted 334.41 million tons of CO2 eq in 2007. Estimates of GHG emissions from the agriculture sector arise from enteric fermentation in livestock, manure management, rice paddy cultivation, and agricultural soils, and on field burning of crop residue. Climate changes in specific rural areas that concentrate specifically on the production of agriculture, may ultimately lower the GDP of Indian states, inadvertently affecting the entire economy (India: Greenhouse Gas Emissions, 2007).

1.1.4 Risks Associated with Climate Changes

Due to anthropogenic activities frequently disrupting the world's atmosphere, rainfall events, the world's average temperature, and droughts are becoming hindering variables to economic risks globally. India is experiencing a warmer climate and these unprecedented spells of hot weather are projected to occur more frequently to larger areas (World Bank, 2013). As stated in the Impact of Climate Change on Indian Agriculture & Its Mitigating Priorities (2016), "India is home to extraordinary variety of climatic regions, ranging from tropical in the south to temperate and alpine in the Himalayan north, where elevated regions receive sustained winter snowfall," (Chakrabarty, 2016).

Over time India has experienced irregular weather conditions such as heavy/low rainfall over certain regions. These changes in climate have led to droughts, flooding, and food scarcity in its agriculture sector. It is undeniable that water plays a key role in the production of agriculture. Due to the co-mingled relationship between agriculture and water, a further analysis of this risk observation is discussed in the water sector portion of this paper.

Heavy monsoon seasons or droughts, also affect the livestock of India. New irrigation systems, under the Accelerated Irrigation Benefit Programme (AIBP), would allow for eight million hectares of land to now have irrigation (Sinha, 2016). Irrigation is important for agriculture, because it allows farmers to not be solely reliant on rainwater. However, Sinha (2016) states that there are over 142 million hectares of net sown land and only 64 million hectares actually use irrigation systems. Maharashtra, Andhra Pradesh, Orissa, Karnataka, and Gujarat were all approved for funding on irrigation projects (Sinha, 2016) which will undoubtedly have a positive result on agriculture, despite the changes in climate.

States like Punjab, the breadbasket of India is a perfect location to exemplify how these natural occurrences have a potential to negatively impact India's agriculture. "Large parts of north-western India, notably the states of Punjab and Haryana, which account for the bulk of the country's rice and wheat output, are extremely water-stressed," (Chakrabarty, 2016). With the population expected to increase, the demand and consumption of grains will increase domestically, but projections show the production of food will yield a low growth.

One major climate change that may have long-lasting effect on Indian agriculture is the increase in temperature throughout the states. According to the World Bank (2013), India's climate has become much warmer and 2016 is on pace to be the hottest. The surge in extreme heat may spread through various areas of India, specifically to the rural community, impacting agriculture, and consequently hindering economic growth. Other contributing factors that can possibly affect the economy are heavy sets of rainfall, scarcity in the water supply, and a rise in sea water that may reach the crops and destroy them (World Bank, 2013).

1.1.5 The Paris Climate Change Agreement

India is already taking active steps to resolving the issue of climate change on Indian agriculture. On October 2, 2016, the birthday of India's peace leader, Mahatma Gandhi, Prime Minister Narendra Modi and India's United Nations Ambassador, Syed Akbaruddin, signed the agreement to seize climate changes and make the planet green friendly. India currently releases 4.5% of greenhouse gas emissions worldwide. The agreement states that all countries who approve of the plan must establish a method to reduce a rise in global temperatures. As for India, it has set that by 2030 it would begin producing 40% of its electricity with instead non-fossil fuel (Hersher, 2016). India should continue to pursue this plan, because it would result in a positive outcome for its economy.

1.2 Water Sector

This paper has identified agricultural production as a major element in the prosperity of the Indian economy and determines that active measures should continue to be taken to prevent and mitigate risks due to the changes in climate. Production of agriculture would be shockingly low or non-existent without sufficient water availability. Adversely, uncontrolled water supply can have a negative impact on agriculture if too much is exposed to crops. India's water crisis has long been an overlooked influence on its economic growth. Water, as a whole is becoming a scarce resource. According to the World Bank Group (2016), "Water security is still considered to be among the top global risks in terms of development impact," and it also acts as an essential part of Sustainable Development Goals, as defined by them. India's economy is growing and will increase the demand for water in all contributing

sectors. In addition to rapid economic growth, the increase in population throughout India also contributes to water shortage. Furthermore, climate inconsistency targets water availability and creates the opening for extreme droughts or flooding in the near future, hindering crisis management and stability in imports and exports. Water is a driving force within the domestic and industrial agricultural sector. Supply chains, productivity, competitiveness, health, and environmental aspects will be affected by a water shortage, a global risk that can harm the economy as a whole.

1.2.1 Risks Associated with Water

The rapid, growing population sets up competition for demand leading to the limited sourcing of water. Households, agriculture and farming, and other service sectors all utilize water, setting up a broad spectrum of consequences for the future of the nation. Furthermore, the high population rate has led to India progressing less than half the rate of other countries around the world in sanitation, according to the World Health Organization (2012), a condition that is exacerbated by water stress, in particular regions of India. On a global scale, water is deemed a finite resource. The demand for water is becoming a more difficult resource to satisfy, with or without environmental variability. It is because of a rapid, growing population, scarce water supply, contaminated waters, as well as the rise in agriculture in the industrial sector that the water crisis persists.

1.2.2 Water Scarcity

Water scarcity is defined as the lack of sufficient water quantity to meet basic needs, as well as the deficit in access to clean water quality. Water proves to be insufficient amongst the people of India due to the consistently rising population and the extreme hot weather spells increasing in many parts of the country. Water stress and water scarcity classification is based on availability of water; a country undergoing water stress has less than 1,700 cubic meters per person per year while a country with less than 1,000 cubic meters per capita per year is classified as water scarce (Luthra & Kudu, 2013). India has the second highest population in the world, with 1.2 billion, as per the 2011 census, but usable water has been estimated to be about 700 to 1,200 billion cubic meters (bcm) (Luthra & Kudu, 2013). This means that India is only obtaining around 1,000 cubic meters per year for each individual in the country. India's water wealth has dropped significantly over the years. For example, the water supply per capita per year in 1951 was estimated at about 5,200 cubic meters and dropped to 1,588 cubic meters by 2010, which if consistent, will drop to 1,401 cubic meters by 2025 (Sharma, 2015). India receives about 4,000 cubic kilometers of annual precipitation (including snowfall) per year, however, it should be noted that distribution of rainfall is scattered, and time-based, and varies in availability across India (Indian Water Resources Society, 2005).

There is significant interdependence in India's agriculture and water sectors. Farmers have an enormous role in India's decreasing water supply. For instance, groundwater supply is diminished due to the over-extraction by the people of India, but mostly significantly by farmers using traditional techniques unchanged for centuries. It has been analyzed that as much as 54 percent of India's groundwater wells are plummeting (Shiao, Maddocks, Carson, & Loizeaux, 2015). Groundwater is water found underground in spaces in soil, sand and rock. It is a free, unblocked resource that anyone can access under their own land. Farmers, especially those residing in dry, unevenly precipitated areas, rely on groundwater for irrigation. Because the ownership of land is already vastly disintegrated, over-extraction is common and expected. In a way, the Indian government already provides electricity and water to farmers for free because they finance farmer's electric water pumping and places no limit on the capacity of groundwater penetrated. The government's support of water pumping is essentially supporting the damaging of the electrical grid, depletion of the groundwater resource as a whole and excessive water use. Groundwater is also a vital source of drinking water in both urban and rural India, and impact to this source is highlighted as a root cause of India's water crisis. Additionally, in 2010 alone, India extracted 251 bcm of groundwater and the rate of extraction has only been growing since then, a significant increase since 1980 when the rate of extraction was baselined at 90 bcm (Luthra & Kundu, 2013). Irrigation is important as Prahbat Singh (2015) states that more than 60% comes from groundwater, and accounts for up to 80% of total water usage in India.

1.2.3 Contaminated Water

Another cause of India's water crisis is poor water quality. Water scarcity due to natural phenomenon and possible climate change, can also be impacted by contamination, pollution, and improper management of wastewater. Contaminated water is the outcome of a deficient amount of water-treatment facilities as well as the deferred investment in urban wastewater treatment processes. India is surrounded by 14 major river systems, but the rivers are not suitable for drinking or washing. The World Health Organization (2012) approximates that 97 million people in India lack access to safe water. Polluted waters can cause harm to the health of India's population as well as add to the already impending insufficient water supply available for use.

Almost every river surrounding India is polluted to some extent due to the fact that approximately 50 million cubic meters of untreated sewage is discharged into them each year (Mistry, 2012). Wastewater, also known as sewage water, can easily run off into water sources and bring on a freshwater crisis. Wastewater is simply a combination of sewage, storm water, and everyone's "already used water." Sewage water consists of: human wastes, food leftovers, oil, soap, fats, sand and other chemicals with high concentrations of toxic metals, fluoride, and Nitrates (Mistry, 2012). Wastewater is a water bowl along with a hint of trash, chemicals, and germs that can damage the environment and people's health. Not treating wastewater before discharging back into waterways pollutes sources of groundwater (Balasubramaniam, 2014). Polluted water seeps into the ground and contaminates agricultural products when used for irrigation. It is a cyclical event that can harm many of India's sectors. The World Bank estimates that 21% of contagious diseases are related to unsafe water (World Health Organization, 2002).

1.2.4 Water Availability and Use

Water sources touch different industrial sectors across India. Groundwater is found to be the most prevalent and easiest source of water to obtain, serving 55% of the economic population while surface water accounts for 51% of water sourcing, and municipal water adds 44% of water sourcing (Perveen, Sen, & Ghosh, 2012). Whereas, water can be obtained from groundwater, surface water, or from municipal water sources, companies and industrial sectors that are contributing to the Indian economy may actually have issues on the availability of water to manage their organizations and tasks. Relatively easy access to water without a price to pay is used up by sourcing groundwater. It is provided for necessary sectors like power and energy transmission, pharmaceuticals and health sciences, agriculture, consumer goods and services as well as banking and infrastructure. However, approximately 48% (almost half) of the companies throughout India state that water is easily accessible, while 28% of other companies reject that because of having to a pay a higher rate for obtaining water (Perveen et al., 2012).

A problem remains with companies claiming that water is not easily available with having to pay a higher price or mention no price factor at all, as they are most affected by their location, such as operations being held in western India and southern India, prone to water disasters. There are water charges for the amount of wastewater discharge, cost of purchasing water from municipal or private suppliers, and capital investment cost of self-sourced water that is obtained from a river or groundwater that municipalities allow industries to source. Results from the land surveying done by the FICCI and CWC (2012), show that surface water is typically used in situations where water may not be easily accessible.

Surface water comes at a higher cost. The report on water risks by the FICCI and CWC also displays a high percentage of surface water usage, estimated at 55%, that belongs to the power, energy, steel, gas and oil sectors (Perveen et al., 2012). Municipal water (tap water that is managed from a central point by government or local authorities (Hunter, MacDonald, & Carter, 2010) is used in only rare cases. Approximately 12% of municipal water alone or five percent of municipal water combined with another source like surface water is mostly used up by the information technology sector in Southern India, around Bangalore (Perveen et al., 2012). Higher costs for water supply occur in the case that the water is controlled, treated, and distributed by national, state, or private administration and may take the form of taxes or a regular charge (Perveen et al., 2012).

Competition for water increases on a daily basis across all sectors and leads to greater pressure to develop more and better surface water storage and groundwater accessibility. Water storage can also enhance both water and economic security while positively impacting agricultural productivity.

1.2.5 Water Treatment and Reuse

Water conservation is becoming a priority for Indian industry. There has already been some initiative from communities and government to work on programs as a shared responsibility within India. However, at the same time, there is rapid expansion of cities and an increase in demand for domestic water. According to Kaur, Wani, Singh, & Lal (2011), as industry moves the nation, wastewater is growing at a proportionately similar rate. Kaur et al. (2011) further indicates that in the future, freshwater availability will decrease and a new wastewater generation will rise due to the proportion of population to industrialization. Present day India has approximately 234 sewage treatment plants (STPs) around the nation. River water projects were initiated in the 1980's and many of the STPs were developed, but that only amounts to just five percent of the cities or states in India that are located around riverbanks. The industrial sector generates approximately 13468 mld (millions of liters per day) and only some 60% is actually treated. The treatment methods that work within the treatment plants are set into phases known as primary, secondary and tertiary phases. Treatment methods go through many stages that require adherence to specific steps necessary to properly sanitize the water being processed. Each of the stages is very important to the procedure because if one step is missed, the water may not be properly sanitized for certain purposes. It has been said that "more than 98 percent of the nation's wastewater treatment facilities only provide secondary treatment,"

(Kaur et al., 2011). Thus, public water is never purified at the optimal level expected by the public.

Although, the management is known, it is not as cost effective, and requires complex operations and/or maintenance. In 2005, the CPCB estimated the total cost for launching treatment systems in an area that covers just domestic wastewater alone to be Rs. 7,560 crores (Kaur et al., 2011, p. 3). Treatment facilities are sometimes not even maintained properly due to inadequate fees being charged for the sanitation service. For the most part, business guidelines on proper waste management are not imposed due to poor mechanical and social resources of the local governments (Luthra & Kundu, 2013).

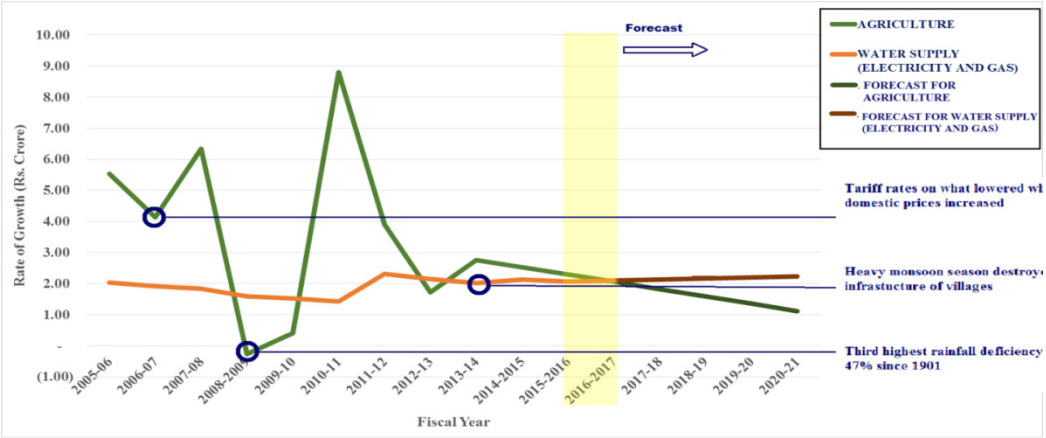

Figure 1. Rate of contribution from primary sector to GDP

2. Methods

2.1 Agriculture Sector

Figure 1 demonstrates the contribution agriculture has on GDP and how it has fluctuated and increased between the years of 2005 up until the projected forecast of 2021. The focus is the sharp decline in 2008-2009 and what may have caused it. Therefore, it is important to understand the impact water has on the agricultural sector. Agriculture production and water are closely related. Approximately 90% of total water is used for agriculture, 80% of land is under cultivation, 65-70% is irrigated, and 55-60% of workers are in the agricultural sector (Narula, Fishman, Polycarpou, & Modi, 2011). Monsoon seasons are of utmost importance to poor Indian farmers. Cultivation of their crops depend, in part, on whether there has been a fulfilling monsoon season or not. The monsoon season is crucial for agriculture because it contributes 18% to the national GDP and employs many of the Indian population. In 2009, the monsoon season was particularly shorter than normally anticipated. In Punjab, a major rice growing state in India, rice flourished because of a groundwater irrigation system, according to Stellar (2009), who also pointed to an increase in energy prices because of the excessive pumping of water. The model in figure 1 shows a corresponding sharp decrease in GDP in 2008-2009 when the drought occurred.

Approximately 253 districts of India were declared drought affected in 2009, and in some instances, like in Andhra Pradesh, they witnessed deaths of farmers (India: Drought, 2009). In figure 1, there is a sharp decrease in agricultural production during 2009 as well, pointing up the inextricable link between water and agriculture. The lack of rain that caused crops to wither, also suggests an increase in price for those that were already fully produced. Figure 1 also suggests that there would be a downward trend in agriculture for the forecasted years of 2017-2021 if the sector is not appropriately managed.

2.2 Water Sector

Climate variability influences the great water crisis that India currently faces. India has been a witness of various accounts of natural disasters that revolve around water sourcing that affect economic sectors. In the summer of 2013, India faced an extreme flooding event due to a heavy monsoon season. The monsoon season, lasts from July to September, but can begin as early as late May or early June. In the summer of 2013, the monsoons arrived two weeks early and blind-sided the nation, leading to little or no crisis readiness (See figure 1). The downpour that occurred for several days in the mountainous area, caused glacial lake dams to cave in. Landslides and continuous water flow became known as India's worst disaster since 2004, when the tsunami hit.

The tsunami alarmed all of Northern India and specifically harmed and destroyed the state of Uttarakhand. The state that is commonly known for its Hindu pilgrimage sites saw damage within all villages, devastated its infrastructure such as highways and roads, and even resulted in approximately 6,000 casualties, and other residents reported to still be missing (Lehane & Sinéad, 2014). The total death toll in the South Asian region was approximately 30,000 people, and nearly one million more were affected by the flood.

In an assessment run by the Global Facility for Disaster Reduction and Recovery and the World Bank Group (2013), the damage of the flooding estimated a $1 billion loss in tourism revenue for the year, and projected that the total recovery period would amount to more than $3.8 billion in economic losses as a whole. There is striking evidence that disaster management relative to the global risk of floods from natural disasters such as the tsunami, impacts GDP as illustrated in the models from figure 1. As the flood hit this valley, there was an instant loss of Rs. Crore 5,400-5,700 to the state's revenue (Times of India, 2014). Due to the fact that the monsoon season is not always consistent, with amounts of rainfall varying, there is a greater effect on agriculture and indirectly on the economy. When heavy flooding occurs, a high salt content also rises and has lasting effects on crops even after a flood recedes.

The model shows a clear relationship between the agriculture and water sectors, and even the service sector, especially tourism. In light of India experiencing the drought of 2009, followed by the heavy monsoon season in 2013, and volatile weather conditions in between, there is a positive correlation for both variables. The ICIC Bank expects India's GDP to drop by 7.3 percent in the current fiscal year if poor rainfall occurs again, but is lower than the initial estimated rate of 7.8 percent (Bundhun, 2015). The direct relationship between agriculture and water shows that if the water supply drops, then the agricultural sector declines as well. When observing, that agriculture makes up a large portion of employment for Indian citizens, it should also be considered that a drastic monsoon season or dry periods can impact other industrial sectors. Apart from a heavy monsoon season putting India's infrastructure and sanitation at risk, it can also cause a loss of energy from blackouts and cause unreliable connectivity, or block out internet connectivity as a whole, which essentially puts much of the services sector at risk. Water supply sets the foundation for crop production and affects state incomes, services, prices, domestic spending and the Indian economy as a whole.

Figure 1 reflects that if left unchecked, the water sector GDP growth rate will be flat over forecast years 2017-2021. Figure 1 also reflects that if left unchecked, the agriculture sector GDP growth rate will be negative over forecast years 2017-2021.

3. Results

A time series analysis was used to identify the nature of these past crises to create a forecast for the years 2016 to 2021. The variables in the forecast include the impact of unmitigated risks from the previous 10 years to predict a decrease or an increase in the rate of contribution to the GDP. The agriculture sector in the model above (figure 1) finds a negatively linear impact of future unmitigated risks. An assumption to the continuous growth of agriculture is a six percent increase starting after 2016, whereas the impact of unmitigated risks results in about a 17% loss of contribution to GDP. For continuous upward growth, the impacts to agriculture must be addressed. Since impacts were caused by natural disasters and climate, it crucial to make suggestions that will allow the agriculture sector to recover promptly before the loss is carried over to the next fiscal year. On the contrary, the forecast for the water sector indicates an upward trend based on past values. According to the time analysis (see figure 1), the forecast for the next five years predicts water consumption rates increase by 33% of the contribution to the GDP. This upward trend for water is expected to be reflected in the occurrences of monsoons and rainfalls, or the improvement of energy prices. Due to the strong linkage, it should be noted that an immediate crisis managed in the agriculture sector must also be addressed in the water sector.

A discussion of risk relative to the natural assets of land and water are linked to the overarching theory of sustainable agriculture, broadly integrating environmental health, economic profitability, and social and economic equity, according to the Sustainable Agriculture Initiative Platform (SAI Platform, 2018). The Council for Social Justice and Peace-GOA (2011), tackled the topic of promoting sustainable agriculture in India and defined sustainable agriculture as any set of agronomic practices that are economically viable, environmentally safe, and socially acceptable.

According to the SAI Platform (2018), a systems perspective is essential to understanding sustainability, from the individual farm, to the local ecosystem, and to communities affected by this farming system both locally and globally. Agriculture cannot be sustainable unless it is economically viable over the long term. For much of the world and for India specifically, conventional agriculture poses greater long-term economic risks than "sustainable" alternatives.

In 2016, the Research and Information System for Developing Countries (RIS) produced for the United Nations a report on *India and Sustainable Development Goals: The Way Forward*, in which they identified the promotion of sustainable agriculture and the sustainable management of water and sanitation as two significant and intertwined goals.

The RIS (2016) says that food production requires "…critical inputs of water and agriculture already accounts for around 70 per cent of global freshwater withdrawals, in a world where some 0.9 billion people lack access to safe water and where demand for water is expected to grow by 40 per cent till 2030." Inextricably linked to agriculture, the RIS (2016) predicts that water demand for irrigation is expected to grow by six per cent in 2050 and is "perceived as one of the main factors behind the increasing global scarcity of freshwater."

Water is required for food production, domestic use, industrial purposes, energy production, and to maintain ecological flows as the RIS (2016) report suggests. For India, there is significant economic risk based on predictions that the country will move into a "water stressed state by 2025." India's agricultural sector gets the lion's share of freshwater allocation—around 80 per cent. Efficiency of water use in India is lower than several other countries and provides an opportunity to reduce use, thus possibly mitigating some of the economic risk associated with these commodities.

The economics of this paper reflected through a financial model illustrate the risks to sectors and the rate of contribution to GDP over the years 2005-2020. This model shows changes in the contribution to India's GDP within the sectors selected over time. Examining key periods of change and mapping them to significant points of crisis, help develop the understanding of the potential threat various risks pose to the economy in India. This model also provides a projection forecast to reflect the amount of value added from each sector or industry if proper precautions are taken to manage the risks as identified.

India's five- year plan for years 2007 to 2012, focused on watershed development, and nongovernmental organizations have shown success toward goals since then. To further illustrate the program's success, the village of Ralegan Siddhi in Maharashtra was transformed by social activists, into a model sustainable village, successful through water harvesting and community assistance in water management. However, rural and urban water supply is a tricky subject due to the fact that poor and unsecured distribution networks lead to large amounts of water left unaccounted for.

India's next five-year plan for years 2013-2017 seeks to focus attention on other water crisis concerns such as aquifer [body of permeable rock that can contain or transmit groundwater] mapping, watershed development, involvement of nongovernmental organizations (NGOs), and productivity in increasing irrigation capacity (Luthra & Kundu, 2013). These tasks, plus the management of polluted waters and greater distribution of knowledge on the water scarcity globally is a good outline of issues to address in order to mitigate the water crisis in India.

4. Discussion

India's agricultural sector is highly vulnerable to climate change in 115 districts across 15 states. The vulnerable districts include Gujarat, Madhya Pradesh, Karnataka, Maharashtra, Andhra Pradesh, Tamil Nadu, eastern Uttar Pradesh, and Bihar. Contrarily, northern Andhra Pradesh and northeastern states are least susceptible to climate change (Manupriya, 2016). Although, the Indian government is already taking proactive steps to combat climate change, such as The Paris Climate Change Agreement (2016), within their nation, it is important to seek out other short term effective ways to further mitigate the problem. In India, roughly 60% of agricultural crops are dependent on rain (World Bank, 2013). Heavy rainfall, or little to no rainfall, may cause a decrease in crop production. In 2050 it is projected that the temperature would rise to about 2°C-2.5°C as opposed to pre-industrial levels, thus water in the Indus, Ganges, and Brahmaputra River will decrease causing a lack of food for roughly 63 million people (World Bank, 2013). One recommendation might be to adopt more resilient crop varieties in addition to water conservation techniques. Manupriya (2016), suggests development and implementation of crops that are resistant to great swings in temperature, droughts or excessive rainfall, or soiled land. This will not only help the production of crops, but will also minimize suicides made by farmers, which proved to be an issue during the 2009 drought.

India water issues are being addressed, but there is still more that can be done. For example, the country has enlisted itself in watershed development that encompasses razing land and selecting rainwater from small land sections and ponds developed from dams in streams. The water collected in this development has increased soil moisture, recharged groundwater and has boosted crop planting (Luthra & Kundu, 2013). Watershed development should be promoted as much as possible. The previous program created a successful sustainable village as a prototype and it is possible to develop sustainability for other states in India in the same way. Based on their

success in developing this model, NGO's should be considered viable partners in an operative and profitable solution to the water crisis (Luthra & Kundu, 2013). The watershed development program also uses dams which are commonly opposed by environmentalists and activist groups, but are considered an efficient way to store water because they work as reservoirs. Dams can be overlooked because they are known for disturbing habitats in forests when swamped and minimizing biodiversity. Conversely, there should be awareness that water can easily be withdrawn into the sea with each monsoon season. It is suggested that scientists, engineers, environmentalists, and activists might find mutually agreeable alternatives if working in collaboration.

Furthermore, the national and state governments should provide communities with information on the nation's current status as well as real-life future scenarios. This is important due to the fact that water management is enhanced through collaboration and cooperation. In the same way, the government can set an initiative by setting monetary incentives of cutting price factors like taxes or placing custom rate exemptions for water accessibility. Pollution control and waste standards should be reinforced by the government. It has been observed that "the technical and human resources currently available … are inadequate to effectively monitor activities, enforce regulations, and convict violators," (Luthra & Kundu, 2013). The National Bureau of Asian Research suggests that, "cities need to charge a proper price for water so that local sewage work operators have the income and resources to sufficiently maintain treatment plants," (Luthra & Kundu, 2013). In that same sense, if the government continues to charge a rate for water supplies of any type, then it should make a distinction between water distribution systems. For example, privatizing a certain percentage of government water sources might help revitalize and modernize the current water systems. Private companies can invest in increasing the number of water treatment facilities since it appears the federal and state governments could use some assistance. It would be a worthy move for India as it could have a direct and positive impact on the nation's GDP. It would also make it easier for the authorities to enforce the importance of water and the crisis that India currently faces. The private sector will help boost research on traditional methods and will enhance or further develop the technical skills of workers in charge of managing water resources and facilities.

5. Conclusion

In conclusion, global risk management extends far beyond a firm's daily business practices and requires planning at a national level to accept risk, mitigate risk, or transfer risk, recognizing the implications of risk to a country's economy. According to the World Economic Forum (2016), the most severe global risks are: ageing population, climate change, polarization of societies, rise of chronic diseases, rise of cyber dependency, rising geographic mobility, wealth disparity, shifts in power, and urbanization.

This paper highlighted two of India's key economic sectors and examined their vulnerability to global risk. According to the Indian Brand Equity Foundation (2015) India's agricultural sector, water sector and its service sector are all strategic locomotives to the continuous development of the Indian nation (IBEF). However, risks identified within each of these sectors that if not managed, may cause future disruption to the economic growth of India. Although there were other present risks, this paper provides an analysis on the risks that may have the greatest effect on the contribution to India's overall gross domestic product. These risks are climate change, trade risk, cyber security, terrorist attacks and water crisis.

A review of the 2016 RIS report details India's commitment to go on record with the world in support of key sustainable development goals, specifically including sustainable agriculture and addressing water scarcity and sanitation. While the country has made laudable progress, they fall short in key areas that have an economic impact. In terms of water resources, one of the biggest challenges are that consensus on the actual water available in India continues to be an elusive quantifiable number. Without scientific consensus on the extent of the resources available, their appropriate management will be next to impossible (RIS, 2016).

The Sustainable Development Goals (SDGs) regarding agriculture are aspirational, but somewhat vague and hard to measure. Further complicating the matter is the fact that agreement with these global goals is not necessarily a major consideration in India's economic policies, with successful concrete measures depending upon how much the SDGs overlap with the domestic agenda. The proposed indicate of success in sustainable agriculture is measuring government expenditures on agriculture is useful, but inadequate (RIS, 2016). And, as with the water problem, there is inadequate means of collecting and reporting data in order to monitor the problem.

While acknowledging some of the shortcomings with regard to specific policy implementation, this paper has prepared a rudimentary model [figure 1] to tackle one aspect of the complex water management issue.

Therefore, the results in figure 1 would extrapolate that due to a dependency on water, a decline in agricultural production would occur if there is an insufficient amount of water supply; a recommendation to mitigate this prominent issue is to adapt better irrigation systems and overall knowledge on water management.

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References

Balasubramaniam, H. (2014). Treating India's wastewater: Why inaction is no longer an option. The Guardian. Retrieved from https://www.theguardian.com/sustainable-business/treating-india-wastewater-inaction-technology-public-health

Bundhun, R. (2015). Weak monsoon sparks industry-wide worries in India. The National-Business. Retrieved from http://www.thenational.ae/business/economy/weak-monsoon-sparks-industry-wide-worries-in-india#full

Chakrabarty, M. (2016). Climate Change and Food Security in India. ORF Issue Brief. Retrieved from http://cf.orfonline.org/wpcontent/uploads/2016/09/ORF_IssueBrief _1571.pdf

Chakraborty, C., & Nunnenkamp, P. (2008). Economic reforms, FDI, and economic growth in India: a sector level analysis. *World Development, 36*(7), 1192-1212. https://doi.org/10.1016/j.worlddev.2007.06.014

Council for Social Justice and Peace-GOA. (2011). Promoting Sustainable Agriculture in India. Retrieved from http://www.csjpgoa.org/employment-and-livelihoods/promoting-sustainable-agriculture-in-india

Directorate of Economics Statistics. (2015). Agricultural Situation in India. Retrieved from http://eands.dacnet.nic.in/publications2015.htm

Global Facility for Disaster Reduction and Recovery & the World Bank. (2013). Stories of Impact: Rapidly Assessing Flood Damage in Uttarakhand, India. Retrieved from http://www.worldbank.org/content/dam/Worldbank/document/drm/gfdrr-stories-of-impact-uttarakhand.pdf

Global Priorities Project. (2016). Global Catastrophic Risks. Retrieved from: http://globalprioritiesproject.org/2016/04/global-catastrophic-risks-2016/

Hersher, R. (2016). India Ratifies Paris Climate Change Agreement. Retrieved from http://www.npr.org/sections/thetwo-way/2016/10/02/496305658/india-ratifies-paris-climate-change-agreement

Hunter, P. R., MacDonald, A. M., & Carter, R. C. (2010). Water Supply and Health. *PLoS Med, 7*(11), e1000361. https://doi.org/10.1371/journal.pmed.1000361

India Brand Equity Foundation. (2016). Indian Financial Services Industry Analysis. Retrieved from http://www.ibef.org/sitemap.xml

India: Drought—Bulletin no.1, 01 Sep 2009. (2009). Retrieved from http://reliefweb.int/report/india/india-drought-bulletin-no1-01-sep-2009

India: Greenhouse Gas Emissions 2007. (2010). Retrieved from http://www.moef.nic.in/downloads/public-information/Report_INCCA.pdf

Kaul, V. (2015). India has enough land for farming but there ...—Firstpost. Retrieved from http://www.firstpost.com/business/india-enough-land-farming-bigger-issues-worry-2032327.html

Kaur, R., Wani, S., Singh, A., & Lal, K. (2011). Wastewater production, treatment and use in India. Retrieved from http://www.ais.unwater.org/ais/pluginfile.php/356/mod_page/content/111/CountryReport_India.pdf

Lehane, S. (2014). India's Food and Water Security—Future Directions International. Retrieved from http://www.futuredirections.org.au/publication/india-s-food-and-water-security/

List of Countries by Projected GDP. (2016). Retrieved from http://statisticstimes.com/economy/countries-by-projected-gdp.php [Figure 1]

Luthra, S., & Kundu, A. (2013). NBR—The National Bureau of Asian Research. Retrieved from http://www.nbr.org/research/activity.aspx?id=356

Manupriya. (2016). Agriculture In 115 Indian Districts Most At Risk From Climate Change. Retrieved from http://www.indiaspend.com/cover-story/agriculture-in-115-indian-districts-most-at-risk-from-climate-change-84356

Mistry, B. (2012). Imminent Water Crisis in India- Report 2012. Retrieved from http://www.kamlafoundation.org/pdf/Kamla Foundation--Water CrisisReport.pdf

Narula, K., Fishman, R., Polycarpou, L., & Modi, V. (2011). Addressing the Water Crisis in Gujarat, India. Retrieved from http://water.columbia.edu/files/2011/11/Gujarat-WP.pd

Perveen, S., Sen, R., & Ghosh, M. (2012). *India's Deepening Water Crisis? Water Risks for Indian Industries*, 1-19. Retrieved from http://water.columbia.edu/files/2012/06/FICCI_CWC_IndiaWaterCrisisPaper.pdf

Research and Information System for Developing Countries. (2016). India and Sustainable Development Goals: The Way Forward. Retrieved from http://ris.org.in/pdf/India_and_Sustainable_Development_Goals_2.pdf

Sharma, R. (2015). India's Water Wealth. Retrieved from http://www.india-wris.nrsc.gov.in/wrpinfo/index.php?title=India's_Water_Wealth

Shiao, T., Maddocks, A., Carson, C., & Loizeaux, E. (2015). 3 Maps Explain India's Growing Water Risks. Retrieved from http://www.wri.org/blog/2015/02/3-maps-explain-india's-growing-water-risks

Singh, P. (2015). India's groundwater crisis. Retrieved from http://www.livemint.com/Opinion/v4nXpXNxSJtxQNlEbvtJFL/Indias-groundwater-crisis.html

Sinha, A. (2016). Water for agriculture: The new irrigation thrust. Retrieved from http://indianexpress.com/article/business/budget/budget-2016-arun-jaitley-india-rural-irrigation-scheme-farm-policy/

Stellar, D. (2009). India: The Impact of the 2009 Monsoon Failure. Retrieved from http://blogs.ei.columbia.edu/2009/09/02/india-the-impact-of-the-2009-monsoon-failure/

Sustainable Agriculture Initiative Platform. (2018). Sustainable agriculture: Definition. Retrieved from http://www.saiplatform.org/sustainable-agriculture/definition

Thenmozhi, S., & Thilagavathi, P. (2014). Impact of Agriculture on Indian Economy. *International Research Journal of Agriculture and Rural Development,* 96-105. Retrieved from http://irjard.nonolympictimes.org/Articles/IRJARD-Dec-2014-9.pdf

The World Bank. Water Overview. (2016). Retrieved from http://www.worldbank.org/en/topic/water/overview

USDA. (2014). India's Agriculture Exports Climbs to Record High. Retrieved from https://www.fas.usda.gov/data/india-s-agricultural-exports-climb-record-high

World Bank. (2015). India poised for 8% GDP growth rate. Retrieved from http://search.proquest.com/docview/1673115927?accountid=12793

World Bank Group. (2016). The World Bank Annual Report 2016. Retrieved from http://www.worldbank.org/en/about/annual-report

World Bank Report. (2013). Retrieved from http://www.worldbank.org/en/news/press-release/2013/06/19/warming-climate-india-pose-significant-risk-agriculture-water-resources-health-says-world-bank-report

World Economic Forum. (2016). Global Risks. Retrieved from https://www.weforum.org/reports/the-global-risks-report-2016

World Health Organization. (2002). The world health report 2002—Reducing Risks, Promoting Healthy Life. Retrieved from http://www.who.int/whr/2002/en/