

## “Dancing with apocalypse”: The impacts of climate change on livelihood of Tuvalu - Polynesia

### ABSTRACT

For community living in Least Developing Countries (LDC) climate change has imposed recent pressure on the locals. The impact it causes is also exacerbated by the inadequate infrastructure and regional policy in those countries. With the focus of interest in the case of Tuvalu, one of LDCs located in Western Oceania which clearly encounters rapid destruction due to climatic events, this paper presents the natural changes and living conditions of Tuvaluan inhabitants. Those calamities are caused predominantly by sea-level rise, warmer temperatures, unprecedented cyclones and contaminated water. Benchmarked with other small islands stretching across the Pacific Ocean, the finding demonstrates that Tuvalu has ignored international concerns due to its critical situations that are caused by the government and local community members.

**KEYWORDS:** Climate Change, Least Developing Countries, Sea level rise, Warmer Temperature, Cyclones, Water Contamination, Tuvalu.

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## INTRODUCTION

The climate change impacts on developing countries are significant. The variation of weather impacts as a factual form of climate change is proven to be devastating for some nations stretching across the southern areas of the Pacific Ocean. In the same vein most of these nations have insufficient capacity to tolerate unprecedented climate change impacts such as drought, unpredictable flooding, landslides and many more. Their susceptible location being an elevation of nearly 2 m lower than the sea level makes the community of Pacific islands living with no choices, except relying on foreign external aid. Many areas in the islands have a very high likelihood of being significantly affected by climatic disasters, leaving the people vulnerable with respect to their future safety.

This paper aims to scrutinize the impact of climate change in Tuvalu, which is ranked as the world's fourth smallest country. Tuvalu has only 26 km<sup>2</sup> of land area with a marine surface area of 750,000 km<sup>2</sup>. It is inhabited by 11,000 people and 90% of the population depends on tourism, shipping transport and catching fish, shrimps and also extracting other sea-based products for their survival. The complexity of the local problems is also increased with the dramatic decline of the water supply in the area which restricts the local populace in meeting their basic needs of drinking, cooking, and nourishing their agricultural products. The saline water intrusion has, moreover, been putting the local population into an unhealthy lifestyle. As the island city is relatively small, people have difficulty in escaping from the zone, as the inter-island transportation is infrequent. In 1994 Tuvalu was declared by United Nations Framework Convention on Climate Change as one of the critical Pacific Islands that may face an immediate reduction in land area and their national governor was warned to prepare for evacuation of the population to neighboring countries.

Accordingly, this paper is in attempt to respond to questions concerning:

- How climate change has put the island inhabitants in extreme risk and
- In what ways local natives strategize their live to cope with the more vulnerable conditions.

Corroborated with secondary data from previous observations this paper is in attempt to enrich the knowledge database on the Pacific Islands and emergent policy making, particularly when it deals with the climate change impacts on the peripheral islands of the country.

## LITERATURE REVIEW ON CLIMATE CHANGE

Viewing climate change from the natural sciences perspective is of importance to provide clear evidence of the cause and drivers that produced this change. It has been a long debate whether climate change is induced by human activities and industrial revolution.

The concentration of methane (CH<sub>4</sub>) as well as carbon dioxide (CO<sub>2</sub>) is regarded as the impetus for climate change. As Scheiner and Lane (2002) argue, the discovery of agriculture and the green revolution in 1960 are the two events assisting natural cooling. Moreover, the burning of fuels on a large scale

has provided clear evidence that mining activities have led to the increase of carbon dioxide by more than 30%, while change in land use from agricultural activities to industries such as cement production and animal farming have been proven to be the one of the greatest contributors of climate change since 1880 (Scheiner & Lane, 2006). Commencing during the industrial revolution when manufacturers shifted to machine-based production, coals were extensively used for powering the factories. According to a scientific calculation, CO<sub>2</sub> in the atmosphere has increased since pre-industrial revolution from a level of 280 ppm to 379 ppm in 2005. Similarly methane increased from 714 ppm to 1,774 ppm in 2005 (Falkner, 2008). This circumstance prompted an average global temperature increase of 0.74° C and is recently predicted to be 4° C so there is a possibility to reach 6.4° C over the 21<sup>st</sup> century.

Increase in chlorofluorocarbon (CFC) has caused holes in the atmospheric layers. Since then, CO<sub>2</sub> accounts for 60% of Greenhouse gas (GHG), while methane gas is 25%. In 2005 CO<sub>2</sub> volume reached 379 ppm, exceeding the natural variability that occurred in the last 600.000 years which was 180-300 ppm. This severe situation is worsened by growth of population, the increase of total GDP, foreign direct investment, water use, chemical fertilizer consumption, mushrooming urban population, uncontrolled paper consumption that demands more tree felling, higher number of motor vehicles and international tourism through airplanes which contributes to carbon emission in the air.

Nevertheless, the caution of climate change must be directed to two main disastrous gases which are carbon dioxide and also methane. It is because carbon dioxide may last for 500 years ahead, while the methane can endure up to 100 years. However, the impact of methane is considered much more destructive than carbon dioxide, so for short-term mitigation the examination of methane gas should be prioritized. The increase in greenhouse gas effects on the earth's surface is contributed from different causes. Combustion of fossil fuels in developing nations is worsened with the widespread practice of slash-and-burn agriculture as one of the prime causes. Another physical consequences of the impact of carbon dioxide divergence on the air was detected in the significant decrease in the amount of incidental heat reaching the land surfaces between 1960 and 1990 and known as "global dimming". The rate of decline varied around the world but is on average estimated at around 2-3% per decade. The effect of dimming is clear, despite the fact that land temperature has increased by 0.4° C over the same period; the largest reductions are found in the northern hemisphere mid latitudes.

Another extent that may accelerate climate change is desertification. Desertification is a permanent formation of desert areas after human activities such as animal husbandry. It has occurred since 1970 with permanent formation of desert areas in sub-Saharan Africa. One of the dramatic effects was that over 100,000 people died and the pastoral economy of the more arid regions was effectively destroyed. Subsequent satellite observation indicated that the extent of the Sahara Desert was closely linked to fluctuations in rainfall and the vegetation which was rapidly regenerated in water years. The analysis of satellite images and rainfall between 1982 and 1999 showed 20% more rainfall when the land is covered with greenery (Burroughs, 2007). Nowadays it is even reckoned that desertification is part of natural complexity where climate change is probably the dominant factor.

On the different side of the globe, it is also worth noting that a surface measurement in Barbados between 1965 and 2000 and satellite observation of dust optical thickness between 1979 and 2000 suggest that background dust loads over the Atlantic ocean have doubled since the mid 1960s. Nevertheless, global dimming on atmospheric dust is also potentially significant for global consequences (BURROUGHS, 2007). Global dimming may take form as physical consequences of particulates released to the atmosphere and has caused a significant decrease in the amount of incidental heat in reaching the land surface. The decline of global dimming can reach 2-3% per decade (BURROUGHS, 2007) due to sulfate aerosol emission into the atmosphere.

The greenhouse gas cycle occurs as the infrared energy absorbed in the atmosphere is reflected to space and then bounced back to the earth surface. The infrared energy that is absorbed in the atmosphere is re-emitted, both out to space and back down towards the Earth's surface. The energy distributed towards the Earth causes its surface to warm further and to emit infrared radiation at a still greater rate, until the emitted radiation is in balance with the absorbed portion of incident sunlight and the other forms of energy merge out from the surface (SCHEINER; LANE, 2006). This cycle causes the increasing heat that causes animals and humans on earth experience warmer temperatures.

The different appearance of the greenhouse effect shows a temperature gap between the earth's surface temperature against temperature which is measured in space after radiation. Therefore it can be simply observed that the heat-trapping of the greenhouse effect is what accounts for 33°C difference between the Earth's actual surface air temperature and that which is measured in space as the Earth's radiation temperature (SCHEINER; LANE, 2006). This is further explanation as to why inevitable warming might not be averted. In response to this concern, Hansen et al (2005) maintain that there is currently a lasting imbalance of some 0.85 to 0.15 Watt/m<sup>2</sup> of extra heat-trapping effects of greenhouse gas buildup over the past century. This evidence predicts that such imbalance contributes to the increase of 0.6°C or more, so then the warming is inevitable even in the unlikely event that greenhouse gas concentrations were frozen at today's level (SCHEINER; LANE, 2006).

Anthropogenic climate change has obviously altered the nature and social landscape. Nature provides resources for human needs and in the same situation human should perceive its response to the change that might be unpredictable and never been forecast previously. Herewith the challenge of understanding vulnerabilities and adaptation should be put forward. The pattern of this change may impact on cultural livelihood where it is inherent to human beings. Adaptation can be understood as "adjustment in a system's behavior and characteristic that enhances its ability to cope with external stress" (WANDEL; SMITH, 2006). In this respect, behavioral change of human will be exposed to the debilitated impacts on environment and this will forces them to conform their attitude accordingly.

Climate adaptation in this context is another circumstance which every one must undergo in order to sustain their lives. Furthermore, economics as a basic way of fulfilling daily necessities cannot be disregarded because it will be also impacted by climate change. A group of human beings without the capability of sustaining will undergo much suffering, as they have no adequate tools to examine and identify how the change has shifted so far. This has been

emphasized by Wandel & Smith (2006) that adjustment in ecological-social and economic system is necessary as a way to avoid a more devastating livelihood. Adjustment itself is culturally embedded within a group as well as an individual because each has a different mechanism of understanding the natural phenomena. In this sense a cultural entity is an extent that should be put forward. Adjustment is exactly a cycle of sustaining life, which informs society to restore and conserve their systems and institutions in which norms, social consensus, customs determine social-cultural landscape.

Risk aversion is what society needs, as suggested by Pielke 1998 (WANDEL; SMITH, 2006. P.15) with “adjustment in individual group and institutional behavior in order to reduce society's vulnerabilities to climate”. From this perspective, institution is a change agent that is capable of determining society to make further decisions regarding their institution. In a basic understanding, Buzer (1989) also comments that cultural adaptation refers to the natural environment through subsistence of activities (WANDEL; SMITH, 2006). An important point to be underpinned here is that activities which are associated with managing resources also depend on the culture of the respective society. Such activities are undertaken in order to maintain and preserve local community who relies for their revenues on local resources for domestic consumption. In response to this case, Wandel and Smith (2006) further emphasize that culture, economics and demography are three simultaneous aspects to change that are impacted by physical environment.

Society is an independent and active entity which can determine which kind of risk that might be less severe or more hazardous. In this respect, some experts frame adaptation as a consequence of making selection through cultural practices in order to preserve a culture (O'Brien and Hollan 1992, in Wandel & Smith 2006) Thus Denevan (in Wandel & Smith 2006) proposes that those who have high adaptability are in a society that maintains its coping capacity with rapid change. Those conceptual underpinnings above brought us to understand why different regions and societies overcome climate change differently.

## **METHODOLOGY**

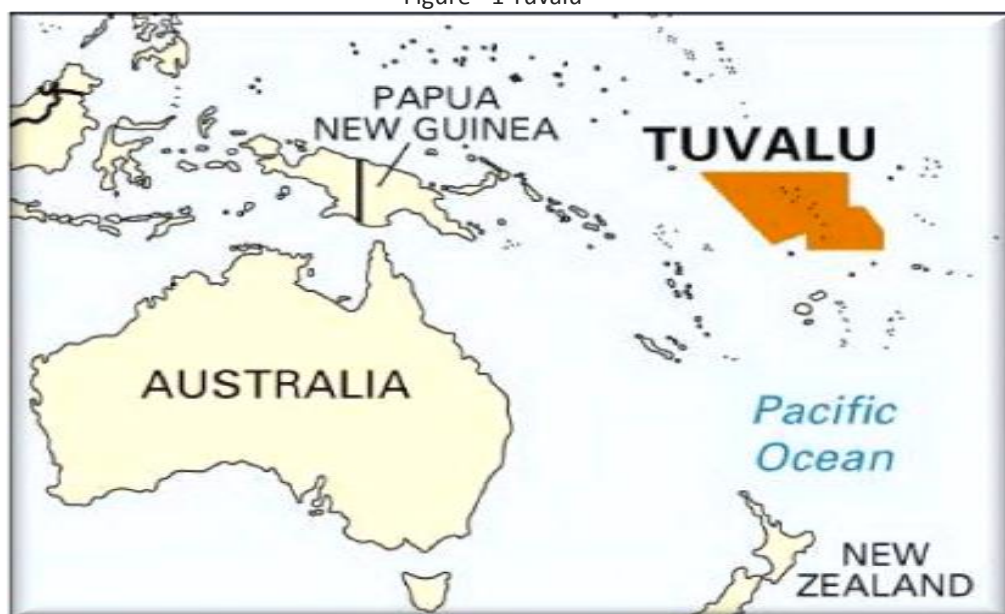
This research mainly stems from field experiences involving direct participation and observational approach. The direct observation was done by touring into the certain areas prone to sea level rise and zones that are claimed to be the most vulnerable zones in Funafuti. Funafuti is an atoll on which the capital of Tuvalu is located. Interviews were conducted with locals who are experiencing day-to-day changes of life and being engaged in a traditional Tuvaluan community. The consultations were undertaken to obtain empirical facts about the ways that locals have been impacted by climatic events on the island. Since the Pacific way of life is more oral than in writing, interviews are a good fit to collect data (WRIGHTON; OVERTON, 2012).

Since this paper aims to capture the level of dangers exacerbated by climate changes from grassroot views and perspectives, qualitative methods with special emphasis on indepth interviews coupled with participant observations are seen as efficient and fit the target of main questions in this research. Due to the short time restriction and limited mobility, only Funafuti was concentrated on as

the research area. Despite focusing on one zone, to anticipate that the data could cover the present situation in Tuvalu, informants were also questioned about current living conditions in other habitable islets that are nearly devastated and the social response elicited by respective stakeholders such as local governments, community leaders, aid mobilizers and even lay persons living there. Each of the informants consented to being recorded for observation. In producing more enlightening insights into the damaging climate change issues in Tuvalu, other internationally recognized articles have been chosen to be incorporated into this paper to allow the reader more understanding on what has been occurring.

### THE LIVES IN TUVALU

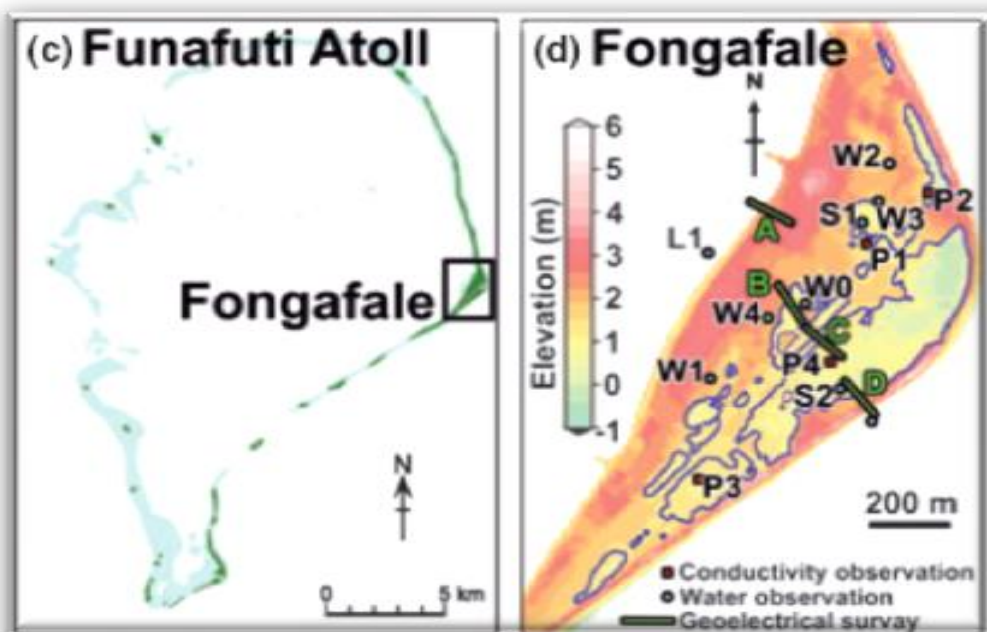
Figure - 1 Tuvalu



Source: <http://kids.britannica.com/comptons/art-55156/Tuvalu-tuvalu-map>

In some international climate debate least developing countries and their existence have been little studied but the impacts of climatic events are enormous and have been exacerbating the human settlements and living resources in the region. Benchmarking with other landlocked states, LDC are faced with the most debilitating effect, including Tuvalu as the fourth smallest least developing country. Stretching across the Pacific Ocean between Kiribati and Fiji Islands, Tuvalu is isolated but filled with rich cultures.

Figure 2 - Land elevation at observation site in Fongafale islet. The red colored zone indicates the most severe low-elevation



Source: Nakada, S., Umezawa, Y., Taniguchi, M., & Yamano, H. (2012).

The municipality is located in Funafuti islet, called Fongafale (NAKADA et al, 2012). Fongafale is one of the islets vulnerable to flooding by rising sea levels. The most striking finding there is that saline water has resurfaced and inundated some local homes when the spring tides occur. Furthermore, other reports reported flooding in some low elevation areas of the islet that has previously been swampland, but were reclaimed during airfield construction in 2012 (YAMANO ET AL, 2007 IN NAKADA, 2012). The island chain stretches 676 km from north to south and covers 757,000 km<sup>2</sup> of ocean. It has a resident population of only around 9,300 people, but has the status of an independent state (Wrighton and Overton, 2012). Featured with atolls, Tuvaluans inhabit nine islands, namely, such Nanumea, Niutao, Nanumaga, Nui, Vaitupu, Nukufetau, Funafuti, Nukulaelae, and Niulakita. The land surface is 26 km<sup>2</sup> which is insufficient for the sustainable dwelling of the local community

It might be understandable if all the economic activities of Tuvaluans are concentrated in Funafuti because it is also a center for trading and goods' export to other island states around Oceania. Due to the small size of Tuvalu, it has no robust economic support and is much reliant on international aid. Aid has been consistently above 30% of gross domestic product (GDP) and at times above 60%. The Pacific island state of Tuvalu is populated with approximately 11,000 with half of this number living in the main urban center of Funafuti (Smith, 2013), but Tuvalu has a major exclusive economic zone in excess of three quarters of a million square kilometres. Growth slowed and the country suffered from a significant bout of inflation stemming from the 2007 oil price spike with the consumer price index peaking at 10.4% in 2008 falling to -0.1% in 2009 and -0.19% in 2010 (PRIDEAUX; MCNAMARA, 2013). The economic slowdown has impacted significantly on Tuvaluan productivity, indicated by a lower demand for Tuvaluan seafarers and falling remittances, volatile exchange rate movements affecting the value of remittances, revenues from fishing license fees and food prices.

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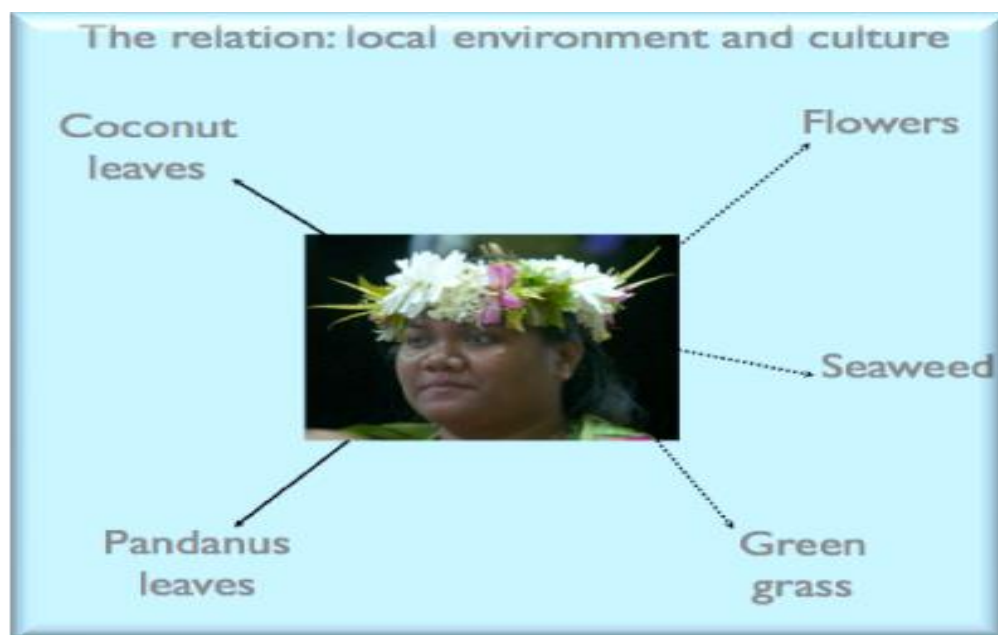
With respect to its economic situation, Tuvalu has a GDP of US\$ 2,615 half of its fellow island state Fiji with US\$4,597. Such a situation persists because Tuvalu, compared with other least developing countries, does not have enough resources. Foreign aid obtained for domestic resources comprises 50%, and other sectors also with minimum contribution to the economy support the nation such as fisheries, seamen remittances and small scale agriculture. Employment structures are not advancing as most of population rely upon casual work with low wages and only 40% of them serve in public sectors.

For years Tuvaluans have conserved a traditional dancing and singing, so-named as *Fatele*. It is performed to commemorate the reign of an *aliki* or *toa* or to worship eminent local figures of their community who have outstanding skill in fishing, canoe making, house building and those who have long struggled for the community wealth. Since Tuvaluans are very cultured, they appreciate nature more than anything. The crown on the head for dancing consists of many items such as coconut trees, pandanus leaves, green grass, flowers and seaweed. These cultural paraphernalia are always attached when people carry out traditional celebration in their community. Departing from this ritual we can acknowledge the relationship between environment and culture that are intertwined in their life. As the climate event has put them in crisis there is a community concern that the scarcity of resources could diminish the capability of Tuvaluans to continue their tradition.

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Figure 3 - Environment and Culture



Source: Courtesy of Lan Marie Nguyen Berg.

In the last two decades Tuvaluans have had nothing meaningful to sustain their lives after realizing the facts of increase in sea level, increase in ocean temperature and unpredictable weather events in its islets. Tuvaluan people have to withstand nature and they must tame it for everyday life. The 11,000 Tuvaluans live on the average 2 to 4 meter high island that may get flooded unpredictably. Surprisingly, the highest point in this island state is nearly 5 meter situated on Niulakita. Meanwhile, the widest part of the island is only 400 meters. Poor quality soil, limited land area for agriculture, scarce water supplies, virtually nonexistent mineral deposits and the environmental toll of obtaining earth minerals all limit Tuvalu's ability to rely on its land resources and thus Tuvalu's only significant economic resources are its marine resources (Siaosi et al, 2012). Tuvalu is situated in the Western and Central Pacific Ocean which is encountering the loss of fish species that are contributive to the country's economic like big-eyed tuna (*Thunnus obesus*), skipjack (*Katsuwonus pelamis*), and yellow fin tuna (*Thunnus albacares*). The highest fish catchment is tuna that accounted for 2,421,113 tons in 2010 and represented 83% of total Pacific Ocean catch (HATCH, 2011 in SIAOSI et al, 2012). The vulnerability of coastal communities and low-lying atoll states to the impacts of climate change and sea-level rise has been recognized for the last two decades and was declared by the formation of the Alliance of Small Island States (AOSIS) (SMITH, 2013). The country is just above sea level and for this reason is highly exposed to climate change (PRIDEAUX; MCNAMARA, 2013).

Figure 4 - Coastal erosion on Nukufetau island.



Source: Courtesy of Lan Marie Nguyen Berg

The climate events that affect Tuvalu may take various forms. As briefly identified it covers higher sea level, warmer ocean, and modified weather patterns. Each of them has differing impacts but overall the human development of Tuvalu is limited. The higher sea level has caused coastal erosion, leveraged fresh water tables, and salinization, and the warmer ocean causes coral bleaching, depletion in fish stock, and biodiversity extinction. Further, unpredictable weather patterns lead to contagious water born diseases, increased intensity of disasters, and changes in rainfall. Ultimately, food insecurity and water scarcity are two current impacts that have subsequent effects on human livelihood in Tuvalu. Since 1950 Tuvalu has experienced a 15cm sea level rise. A local parliamentary member named Enele Sopoaga, met during the research, revealed that the king tides have started flooding around his house and thus devastating papaya and banana trees.

Other trees on the coastline are washed away due to the extensive coastal erosion, followed by more consequences of salinization. The underground water levels including local wells are massively intruded with sea water which is toxic for humans and plants. The phenomenon of a warmer ocean has been very immense since 1850 in South Pacific ocean. In Tuvalu the observable temperature increase is 0.70 C on the both land and ocean. The diminishing rate of fish and coral is because the ocean has warmed to 29.0 C. The consequences that have been arising include coral bleaching so that there is no more natural protection for baby fish, causing depletion in fish stock. Moreover, the income of local peoples from the local fishery sector declines. Cyclones in the Western Pacific are reportedly becoming severe and the frequency is predicted to rise in later decades. Tuvalu and Kiribati which have many low lying areas will be the first areas to be rapidly affected by the cyclones. More impacts may not be able to be resisted as disaster risk mitigation with safe emergency centers are not widely

available in the island. One cyclone itself eroded 140 hectares of sediment on the shore and produced a 3.5 meter high rampart on the coastline of Funafuti.

Heavy rainfall is noted as highest between 1933 and 2008 and followed with prolonged drought. Funafuti would be unable to provide water sanitation to the entire population (IPCC, 2007). Access to drinking water is an essential resource but the inability to produce food crops is less of an issue if communities have the means to purchase imported food. It should also be noted that reliance on imported, processed food does have considerable implications for health, and Pacific Island communities have some of the highest level of non-communicable diseases, such as obesity, heart disease and diabetes (SMITH, 2013).

From the current findings in Tuvalu, it is informed that less than 50 l/c/d (liter per capita per month) have been consumed by the people since the 1980's. Since that time the government of Tuvalu has adopted a national objective to prioritize water catchment installation because the water resource is becoming so depleted. As affirmative action, all developers must attain a Certificate of Occupation, ensuring that the building would meet the Water Resource Act of Tuvalu. The government of Tuvalu confiscates those who are not abide by this strict bylaw. Sadly, on the outer island of Tuvalu 59 percent of local water containers are contaminated with bacteria and the locals are exposed to dangerous diseases. Water seems to be central problem in Tuvalu. Human excreta contamination takes place due to low standards in septic tank construction. In the local housing 98 percent of septic tanks wastage are funnelled into ground water so it poses inevitable direct impacts to the quality of underground water in the island. In most of the zones water catchment also becomes a public issue. In spite of the availability of catchment surface with average holding capacity of 5,500 litre per capita only 29% of the population can meet the legal requirements of 10 m<sup>2</sup> per capita of catchment surface. The catchment becomes severe because the average rainfall precipitations cannot be accommodated. The high average rainfall is 3.500 mm/year in Funafuti.

## **GENERAL CONCLUSION**

Through this research it has been observed in the Pacific that small islands have been vulnerable for years to climatic events especially those associated with sea-level rise, impacts of cyclone, rainfall and the increasing local temperature. The effects of these events exacerbate the complex nature of community living in fragile circumstances yet under extreme poverty. Departing from this, a concerted global effort to provide assistance in order to reduce climate change impacts in Tuvalu is imperative.

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## “Dançando com o apocalypse”: Os impactos das mudanças climáticas para subsistência em Tuvalu - Polinésia

### RESUMO

Para a comunidade que vive nos Países Menos Desenvolvidos (PMA) a mudança climática tem imposto pressão recente sobre os locais. O impacto que provoca é também exacerbado pela inadequação das infra-estruturas e da política regional nesses países. Com o foco de interesse no caso de Tuvalu, um dos PMDs localizados na Oceania Ocidental que claramente encontra rápida destruição devido a eventos climáticos, este artigo apresenta as mudanças naturais e as condições de vida dos habitantes de Tuvalu. Essas calamidades são causadas predominantemente pelo aumento do nível do mar, temperaturas mais quentes, ciclones sem precedentes e água contaminada. Benchmarkado com outras ilhas pequenas que se estendem através do Oceano Pacífico, o achado demonstra que Tuvalu ignorou interesses internacionais devido a suas situações críticas que são causadas pelo governo e por membros locais da comunidade.

**PALAVRAS-CHAVE:** Mudança Climática. Países Menos Desenvolvidos. Aumento do nível do mar. Temperatura Mais Quente. Ciclones. Contaminação da Água, Tuvalu.

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