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# Economic impact of climate change and climate change adaptation strategies for fisheries sector in Fiji

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## ABSTRACT

Capture fisheries and aquaculture sectors have played major roles in the national economy and food security of Fiji. But climate change may place substantial stress on these sectors within this archipelago. This paper assesses the potential economic impact of two important climate change adaptation strategies in Fiji, natural resource management (NRM) and aquaculture, using a market fish supply–demand model. The model undertakes a comparative analysis of alternative fisheries development scenarios for 2035 and 2050, while taking account of the impact of climate change on the fisheries sector. The modeling and scenario analyses show that promoting aquaculture can help raise aggregate fish production, consumption, and trade. However, the required increases in aquaculture could be massive. While aquaculture development alone is unlikely to meet the growing excess demand for fish in Fiji, it will be an important component in adapting to the negative effects of climate change on capture fisheries. Various NRM strategies, such as marine protected areas (MPAs) and locally managed marine areas (LMMAs), are projected to have positive impacts in Fiji, expanding the stock and catch of fish. But current efforts on various NRM strategies are too small to have any meaningful impact to reverse the declining trends of coastal fisheries catch. Efforts would need to be greatly scaled-up to achieve significant production gains.

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## 1. Introduction

Fiji (officially known as the Republic of Fiji) is an archipelago comprising approximately 844 volcanic and coral islands with a total water area and exclusive economic zone of 1,290,000 square kilometers (km<sup>2</sup>) [1,2]. Given its geographic location and environment, the fisheries<sup>1</sup> sector is an important element of Fijian economy. Fisheries enhances food and nutrition security, particularly in the rural coastal areas, and contributes to livelihood and income generation, rural development, environmental preservation, and Fiji's gross domestic product [3–6].

The Food and Agriculture Organization of the United Nations

(FAO) broadly categorized the fisheries sector into six main areas: coastal subsistence fishing, coastal commercial fishing, offshore locally-based fishing, offshore foreign-based fishing, freshwater fishing, and aquaculture. Of these six, fish production was found to be highest in Fiji's coastal areas [1,3,4]. Artisanal or small-scale commercial and subsistence fishers are heavily dependent on coastal areas as sources of fish for food, nutrition, livelihood, and income.

The management of fisheries resources in Fiji is divided among national ministries, provincial governments, and indigenous Fijian institutions<sup>2</sup>. At the national level, the Department of Fisheries (DOF) is the main agency responsible for fisheries resources management. DOF regulates fishing (catch limits and entry) mainly through the issuance of permits and licenses. However, effective implementation of fisheries regulations is often hampered by various administrative and budgetary constraints,

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<sup>1</sup> In this paper, unless otherwise specified, the term “fisheries” is used broadly to include capture fisheries and aquaculture, and the term “fish” is also broadly defined to include finfish, mollusks and crustaceans.

<sup>2</sup> Another paper of this special section of Marine Policy [7] discusses existing fisheries policies in four Pacific countries, including Fiji.

including split jurisdiction of different agencies [8]. Subsistence fishing and non-commercial fishing gear types are not subject to permit requirements [8].

Climate change is expected to place substantial stress on the capture fisheries and aquaculture sector of Fiji [9] and result in reduction of coastal subsistence fisheries [10] under business-as-usual scenarios. Similar to other Pacific and developing countries, the Government of the Republic of Fiji has begun preparing a National Adaptation Programme of Action and in 2012 developed a *National Climate Change Adaptation Strategy for Land-Based Resources 2012–2021* [11]. In 2012, the Secretariat of the Pacific Community (SPC), in cooperation with the Fiji national team on climate change and other stakeholders, developed the *Republic of Fiji National Climate Change Policy* [12]. These documents recognize Fiji's vulnerability to climate change and offer disaster risk-reduction approaches to combat the impacts of extreme weather events.

Numerous studies have profiled Fiji's fisheries (see, for example, [1–4,10]), and some include analyses of climate change impact, related adaptation strategies and their agro-ecological impacts in Fiji (see, for example [13–19]). However, there are no in-depth studies that tackle the economic impact of Fiji's climate change adaptation strategies. In an effort to address this knowledge gap, this paper examines the potential economic impacts of climate change adaptation strategies on the fisheries sector in Fiji.

## 2. Climate change and related adoption strategies for the fisheries sector

Climate change adaptation strategies in Fiji include various natural resource management (NRM) practices, including marine protected areas (MPAs), locally managed marine areas (LMMAs) and the ridge-to-reef concept; alternative livelihood developments; enforcement of Department of Fisheries (DOF) regulations and compliance with the fisheries regulations and ordinances; inshore low-cost fish aggregating devices (FADs); aquaculture; finance literacy; and post-harvest—improving the quality of products and reducing waste. Among these, NRM strategies and aquaculture are featured most prominently in the government and commonly reported as important climate change adaptation strategies.

“[MPAs] are clearly defined geographical spaces that are recognized, dedicated, and managed through legal or other effective means, to achieve long-term conservation of nature with associated ecosystem services and cultural values (Govan et al. [20])”. MPAs are covered under the 2007 *National Biodiversity Strategy and Action Plan* and the Fisheries Act in Fiji. In contrast, “LMMAs are areas of nearshore waters and coastal resources that are largely or wholly managed at a local level by the coastal communities, land-owning groups, partner organizations, and/or collaborative government representatives who reside or are based in the immediate area (Govan et al. [20])”. The main difference between LMMAs and MPAs is that the former emphasize management by local communities and do not necessarily ban all extractive activities such as inherent in MPAs.

Fish aggregating devices (FADs) have been used in Fiji since 1970 to collect all sizes of fish from nearby reefs. Piles of vegetation such as tree logs, branches, bamboo, and coconut leaves are used to attract fish. Two types of FADs are typically constructed in Fiji: inshore (near-shore) and offshore. Near-shore FADs can be used as part of LMMAs.

Finally, fish farming or aquaculture was first initiated in 1976 by DOF with the introduction of Nile tilapia [21] and now include freshwater prawn, grass carps, and silver carps, to name a few. Culture of milkfish, seaweed, and pearls is also under

development<sup>3</sup>. The importance of aquaculture has been increasing in Fiji in recent decades with national consumer preferences geared towards tilapia and prawn.

## 3. Methodology and data

This study uses a fish market supply–demand model that represents climate change in terms of supply shocks. The model undertakes comparative analysis of alternative fisheries development scenarios for 2035 and 2050, while taking account of the impact of climate change in the fisheries sector. The details of the model are presented in another paper in this special section of Marine Policy [22].

Evaluation of the impact of a climate change adaptation strategy requires a baseline scenario of no adaptation (i.e., a benchmark of “no action”). For each time period (2035 and 2050), two baseline (most plausible with no climate change adaptation strategy) scenarios<sup>4</sup> have been implemented. These scenarios represent two annual growth rates of real per capita income: medium (1% per year) and high (2% per year) growth of real per capita income. During 2008 to 2012, annual percentage growth rate of real per capita income in Fiji ranged from –2.3% to +1.4% [23]. Populations of 977,586 in 2035 and 1,060,706 in 2050 [1] has been assumed for Fiji.

The data needed to run the model were collected from both primary and secondary sources. Primary data sources include expert opinion survey (EOS) and focus group discussion (FGD). The EOS was conducted in Suva in July 2012. Experts from the Department of Environment, Department of Agriculture, Climate Change Unit, Ministry of Fisheries and Forestry, Ministry of Itaukei, National Project Management Unit-ANZDEC, and national research partners participated in the survey. A field visit to Vitawa village, Ra province, was made to implement the participatory rural appraisal (PRA) using FGD with fish farmers on 30–31 July 2012. Similarly, an FGD with capture fishers was implemented in Namauida village, Ra province, during the same month.

The Fiji model, the data used in the model, and the preliminary results were presented to stakeholders at a “Model Validation” meeting held in Suva, Fiji, on 25 June 2013. Based on the comments received during the validation meeting, as well as comments from other experts (e.g., participants of the North American Association of Fisheries Economists 2013 meeting), minor revision to the model was made and this was implemented in various scenarios. The validated baseline data (production, consumption, trade, and price), supply elasticities, and demand elasticities that were used in the model for Fiji are given in Appendix Tables A.1, A.2, and A.3, respectively. The supply quantities reported in Table A.1 do not include catch by foreign fleets. Broadly speaking, there are three types of tuna and oceanic catches: catch by domestic/national fleets in national waters, catch by domestic fleets in international waters, and catch by foreign fleets in national waters. The supply volumes reported in the Appendix Table A.1 and used in the analysis include catch by national fleets in both national and international waters, but do not include catch by foreign fleets in national waters. Foreign vessel catch in Fijian water is not substantial.

The fish demand elasticities used in the model reflect consumers' preference patterns in Fiji and substitutability of various

<sup>3</sup> Riverine stocking of tilapia was also practiced in river systems, such as in Tailevu and Rewa Delta; however, DOF now discourages this practice because of biodiversity concerns [21].

<sup>4</sup> Given the uncertainty of establishing future income growth, two alternative baseline scenarios with different growth rates of real per capita income were presented.

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