Ecological Economics 142 (2017) 91–103

Contents lists available at ScienceDirect

Ecological Economics

journal homepage: www.elsevier.com/locate/ecolecon

# When Patience Leads to Destruction: The Curious Case of Individual Time Preferences and the Adoption of Destructive Fishing Gears

Aneeque Javaid [a,d,e,*], Marco A. Janssen [b,c], Hauke Reuter [d,f], Achim Schlüter [d,e]

[a] Institut für Umweltsystemforschung, Universität Osnabrück, Osnabrück, Germany
[b] School of Sustainability, Arizona State University, Tempe, AZ, United States
[c] Center for Behavior, Institutions and the Environment, Arizona State University, Tempe, AZ, United States
[d] Leibniz center for Tropical Marine Ecology (Zmt), Bremen, Germany
[e] Jacobs University Bremen, Germany
[f] Faculty of Biology and Chemistry, University of Bremen, Bremen, Germany

ARTICLE INFO

*Article history:*
Received 13 December 2016
Received in revised form 3 April 2017
Accepted 8 June 2017
Available online 23 June 2017

*Keywords:*
Individual Time Preferences
Time Discounting
Natural Resource Extraction
Fisheries
Destructive Fishing Methods
Agent Based Modeling

ABSTRACT

The use of destructive fishing methods is a serious problem, especially for tropical and developing countries. Due to inter temporal nature of fisheries extraction activities, standard economic theory suggests that an individual's time preference can play a major role in determining the gear choice decision. Based on earlier theoretical work we identify two ways in which individual time preferences can impact the adoption of destructive extraction methods; (i) the conservation effect which posits that patient individuals (as indicated by relatively high discount factor) are less likely to use destructive extraction methods since they are more likely to account for the loss of future income that is accompanied by using these methods, (ii) the disinvestment effect which argues that patient individuals are more likely to use destructive extraction methods since they have greater investment capability.

Using an agent-based model we clarify the conditions under which one of these effects is more dominant than the other one. Our model suggests that the nature of destructive gear along with the level of social dilemma determines whether patient or impatient individuals (relatively lower discount factor) are more likely to adopt such a gear. Additionally agent's beliefs regarding future resource condition and other agent's extraction level can have a major influence in some cases.



## 1. Introduction

Destructive fishing is considered to be one of the most important problems in marine governance (Clark et al., 2005; Sethi et al., 2005). According to the United Nations Environment Program, about 25% of fisheries worldwide are in jeopardy of collapse due to destructive fishing (Shakouri et al., 2010). The threat of destructive fishing, such as the use of poison, dynamite and illegal nets, is especially devastating for inshore fisheries in tropical and developing countries where small communities are engaged in subsistence fishing (Belton and Thilsted, 2014). The collapse or even serious degradation of local fisheries due to the use of destructive fishing gears has a very negative impact on the material well-being of these communities. As a result, there have been frequent attempts to persuade fishers who are using destructive gears to change their behavior, and switch to more environmentally-friendly fishing gears (Samoilys et al., 2008). In most cases this involves policy measures, such as gear-exchange programs or monetary incentives for resource conservation (Verheij et al., 2004). These policies are motivated by the assumption that a major motivation for using destructive fishing gear is impatience or short-sightedness (low discount factors) and the lack of availability of high capital stocks.

This assumption is based on standard economic models of renewable resources, going back to Hotelling (1931), which frame natural resource extraction as an intertemporal optimization problem, where discount factors[1] indicate the value given to expected future consumption. This implies that, higher discount factors meaning higher valuation of expected future consumption, leads to lower rates of extraction and vice versa. Following Farzin (1984) we refer to this as *the conservation effect*. However Farzin (1984) offers a different point of view and argues that, for high cost of extraction, the relationship between discount factors and resource extraction is opposite to the generally held one, meaning that higher discount factors result in higher extraction levels and

* Corresponding author at: Institut für Umweltsystemforschung, Universität Osnabrück, Osnabrück, Germany.
*E-mail address:* aneeque.javaid@uni-osnabrueck.de (A. Javaid).

[1] Throughout the article we use the term discount factor (IDF); where 0 is impatient and 1 means patient. IDF is inversely related to discount rates, so IDF = (1 + r)^ − 1; where r is the individual discount rate.

http://dx.doi.org/10.1016/j.ecolecon.2017.06.007
0921-8009/

vice versa. This is based on the view, that, patient fishers are able to invest more in their extraction capabilities. We refer to this as *the disinvestment effect*.

We add to this discussion by applying the underlying logic of these models to the specific context of the adoption of destructive fishing gears in small-scale artisanal fisheries. Our main objective is to distinguish between scenarios where the policies based on the conservation effect are justified and the conditions under which they are not justified. Typical policies, like livelihood diversification or temporal closures with income compensation, may lead to undesirable effects in a situation when the disinvestment effect dominates the conservation effect. We contribute to solving this conundrum, by providing a better understanding of fisher's motivation to adopt destructive gears and its relationship to individual time preferences.

This research question is motivated by empirical research in Zanzibar which suggests that patient fishermen have higher extraction level since they can invest more in their extraction capability (see Javaid et al., 2016). This surprising finding triggered some interesting and unanswered questions. Does the relationship between time preferences and extraction behavior change depending on the circumstances? What role do external factors play in this decision-making? How do beliefs and perceptions impact this relationship? While these questions are motivated and based on empirical research in Zanzibar fisheries, they are not limited to this case. The use of destructive fishing gear is common in other regions as well, such as different parts of East Africa (Guard and Masaiganah, 1997; Cinner, 2009; Wells, 2009), Indonesia and other parts of Southeast Asia (Cassels et al., 2005; Burke et al., 2006), parts of South Asia (Rajasuriya et al., 2004) along with other developing and developed country fisheries. For the purpose of this paper we limit ourselves to focus on the case of destructive fishing gears in small scale communities with open or shared access to the resource.

Our model shows that the impact of individual discount factor on the adoption of destructive fishing gears is mediated by two key factors; (i) the nature of destructive gear i.e. whether the destructive gear is cost-cutting low-profit gear or whether it is high-cost high-profit fishing gear, and (ii) the level of social dilemma, meaning the number of people who share the same resource. Additionally, we find that individual beliefs about the actions of other resource users and future resource condition can have a significant influence on whether the conservation effect prevails or not. Overall, our model helps in clarifying the conditions under which the above mentioned policy measures may be expected to work as intended and conditions where other alternative policy measures should be adopted.

## 2. Background Information

### 2.1. Destructive Extraction Methods

Destructive methods are defined as fishing methods, gears or practices whose impact is so indiscriminate and/or irreversible that they are universally considered destructive irrespective of the environment in which they are used (FAO 2005–2014). In more concrete terms, these destructive fishing gears typically have a higher propensity to physically damage habitats like corals reefs, capture a high proportion of juvenile fish, or target species that are crucial to sustain (McClanahan and Mangi, 2001; McClanahan and Mangi, 2004; Mangi and Roberts, 2006; Mangi et al., 2007). Examples of destructive gears in small scale fisheries include beach seine, ring nets, explosives/dynamites, spear-guns and poison(Jiddawi and Öhman, 2002; Cinner, 2009).

In small-scale fisheries, destructive fishing gears can range from highly profitable to those which are even less profitable than the traditional gears. Similarly, in terms of capital costs (both fixed and maintenance), some destructive fishing gears (such as beach seines and dynamites) are much more expensive than traditional gears, while others (such as spear guns or poison) are less capital intensive even compared to most basic traditional gears. Similar comparison can be made between labor cost required to maintain and operate destructive fishing gears (for more details see Mangi et al. (2007)). What drives people towards these gears is an extremely important and relatively under-researched question. It stands to reason that given this variation in types of destructive gears, different fishers are attracted to different destructive gears. Earlier studies argue that destructive gear usage is often associated with a combination of poverty, low socio-economic conditions and myopic behavior (Cinner, 2009; Silva, 2006). Similarly others have argued that institutional and normative factors can also play an important role in destructive gear choice (Wallner-Hahn et al., 2016).

### 2.2. Destructive Fishing Methods and Time Preferences

In economics, time preferences refer to the relative value given to future utility as compared to present utility. Earlier research shows that there is a considerable degree of heterogeneity in individual time preferences, some value future consumption very highly while others do not (Tanaka et al., 2010). Similar pattern can be observed for natural resource-users (fishers) as well (Teh et al., 2014). According to standard economic models, fishers with high value for present consumption are likely to extract more resources (Koopmans, 1974). This can lead to the choice of destructive methods, as these gears often provide higher benefits in the present, but destroy future harvest possibilities. Furthermore, unlike overfishing, the damage caused by using destructive fishing gear is highly visible and occurs in very short time period (Cinner, 2009). Therefore, fishers using destructive fishing methods are more aware of the fact that they are causing serious long term damage to the resource, and that the future productivity of the resource is going to be very low as a result of their actions. This suggests that people with relatively lower subjective value of future consumption (impatient fishers) are more likely to use destructive fishing gears as compared to those who give higher subjective value to future consumption (patient fishers), as they can enjoy higher immediate consumption even at the cost of potentially large decrease in future consumption.

However, these standard economic models do not account for the fact that, adoption of destructive gears typically requires initial investment (both capital and time investment in learning to operate the new gear) (Farzin, 1984). Destructive fishing methods can be more expensive, either in terms of fixed or variable costs than the traditional methods. Investing a substantial amount of money in buying a destructive gear means that this money is not available for present consumption. This consideration is especially important for artisanal fishers, who in general don't possess large reserve capital (Cinner, 2009). Overall, this point of view suggests that higher preference for present consumption is negatively associated with the possibility of using destructive gear, as these gears generally require larger initial investment.

Thus, we have two competing accounts of the impact of individual time preferences on the decision to adopt destructive fishing methods. In this paper, we try to understand the conditions and assumptions under which the conservation effect overtakes disinvestment effect and vice versa.

### 2.3. Adoption of Destructive Extraction Methods as Technology Diffusion Phenomenon

The stereotypical description of artisanal communities is fishers engaged in traditional or primitive methods threatened by the advent of large-scale modern fishing industry. However, in many cases, these artisanal fishers are aware of small-scale innovations in extraction methods. These innovative, yet destructive fishing methods are adopted relatively slowly due to the associated risks and learning effects. In general, these methods start from a small area and spread to different fishing sites over time (Wells, 2009).