Fisheries subsidies and potential catch loss in SIDS Exclusive Economic Zones: Food security implications

U. Rashid Sumaila[1], Andrew Dyck[1] and William W. L. Cheung[2]

1. Fisheries Economics Research Unit, Fisheries Centre, University of British Columbia, Vancouver, Canada, V6T 1E4.

2. School of Environmental Sciences, University of East Anglia, Norwich, U.K. NR4 7TJ.

Abstract: We aim to provide an understanding of the effects of providing subsidies to the fisheries in Small Island Developing States (SIDS), where fisheries are important to both the food security and livelihoods of the populations. More specifically, our objectives are to (i) present information on current and potential catch and compute the potential catch losses from the Exclusive Economic Zones (EEZs) of SIDS; (ii) analyze the food security implications of the estimated catch loss potential; (iii) present and analyze the amount and types of subsidies provided by Small Island Developing States (SIDS) to their fishing sector separately and collectively; and (iv) analyze the effect of fisheries subsidies on overfishing in the EEZs of SIDS. We find that collectively, SIDS have currently overfished their waters to the extent that their current catch is just under 50% of the maximum catch potential. This catch loss results in a loss of opportunity in meeting the nutritional requirements of over 600 million people living within and outside of SIDS. Our results also demonstrate that capacity-enhancing subsidies contribute to overfishing while the effect of good subsidies is unclear and needs further analysis.

Key words: Subsidies, overfishing, catch loss, food security

1 Introduction

Global wild fish catch reached its maximum limits in the mid 1980s, and has started to decline, mainly because of over-exploitation and depletion of fish stocks (e.g., Pauly *et al*. 2002; Myers & Worm 2003). The over-exploitation of fish stocks started in the North Atlantic and North Pacific, where industrial fishing began in the late 19th and early 20th centuries. It then expanded to the continental shelf and coastal waters of other ocean basins, including those in Small Island Developing States (SIDs) and then to the high and deep seas (Sumaila and Cheung, 2009). Fisheries are important in developing coastal countries, in general, and in the Small Island Developing States, in particular, for a variety of reasons: (i) fish is a source of animal protein for the populations of SIDS; (ii) fisheries are an important source of foreign exchange for many of SIDS; and (iii) fisheries are a source of income and livelihoods to millions of people in these countries, many of whom are employed in small-scale fisheries.

Over-exploitation of fish socks results in substantial socio-economic loss to fishing enterprises and communities (World Bank and FAO 2008). It also threatens the long-term survival of marine species, in particular, those that are vulnerable to fishing (Hutchings & Reynolds 2004). The long-term sustainability (ecological, economic and social) of targeting many fish stocks in the world is seriously in doubt (Pauly *et al*. 2002; Worm *et al*. 2006).

At the same time that fish stocks are being over-exploited, subsidies are being provided to the fishing sector by many governments around the world. It is generally accepted by fisheries scholars and scientists that fisheries subsidies are a driving factor for the build-up of excessive fishing capacity, thereby undermining the sustainability of marine resources and the livelihoods that depend on them

(FAO, 2001; Milazzo, 1998). Subsidies that reduce the cost of fisheries operations and those that enhance revenues make fishing enterprises more profitable than they would be otherwise. Such subsidies result in fishery resources being overexploited, as they contribute directly or indirectly to the build-up of excessive fishing capacity (Milazzo, 1998), thereby undermining the sustainability of marine living resources and the livelihoods that depend on them (Sumaila *et al.*, 2010). In this paper, this type of subsidies is considered capacity-enhancing or 'bad' subsidies because of their negative effects on fisheries sustainability.

Global estimates of fishery subsidies in general have been provided earlier by the FAO (1992) and Milazzo (1998). Regional estimates of fisheries subsidies have also been provided for the Asia Pacific Rim by APEC (2000) and for the North Atlantic by Munro and Sumaila (2002). The OECD publishes annual fisheries subsidies estimates for its member countries (OECD, 2004; 2005a).

We first present information on current and potential catch, and compute the potential catch losses from the Exclusive Economic Zones (EEZs) of SIDS due to ineffective management. Next, we analyze the food security implications of the estimated catch loss potential. Then we present and analyze the amount and types of subsidies provided by SIDS to their fishing sector separately and collectively; and analyze the effect of fisheries subsidies on overfishing in the EEZs of SIDS.

2 Methods

For the purposes of this study, we use the United Nations definition of Small Island Developing States, which includes 51 countries/entities (http://www.un.org/special-rep/ohrlls/sid/list.htm). Note that for this analysis, political entities are not counted separately from their parent countries. Hence, American Samoa, which is one of the 14 dependents of countries listed, is combined with the United States. We therefore included 37 SIDS in our analysis, except Bahrain because of lack of data. Of the 37 countries, 16 are from the Caribbean; 12 in Oceania, 6 in Africa and 3 from Asia (Table 1).

Insert Table 1 here!

2.1 Potential catch loss in SIDS

We determine the current and potential catch from the Exclusive Economic Zones of the 37 SIDS using estimated maximum sustainable yields (MSYs) reported in Srinivasan *et al.* (2010). The catch loss, that is, catches foregone due to fishing beyond sustainable levels (i.e., due to overfishing) are calculated by combining MSY data with current catch reported in the *Sea Around Us* project database (http://seaaroundus.org/). In brief, MSY for each fisheries stock (taxonomic unit reported in the FAO landings statistics) in the Exclusive Economic Zones of SIDS is calculated from the maximum catch of the time-series catch data, smoothed by 5-year running mean Srinivasan *et al.* (2010). The calculated maximum catches are then converted into MSYs using an empirical equation describing the relationship

between observed maximum catches and the theoretical MSY of a stock (see Srinivasan *et al*. 2010 for details). Stocks are considered overfished if maximum catch has already been reached in catch time-series and that the current catch is below 50% of the maximum catch. Catch loss of these stocks are calculated from the difference between the current (2005) catch and their estimated MSYs.

2.2 Analysis of the food security implications of catch losses in SIDS

Here, we explore the socioeconomic and food security implications of the failure to manage fisheries in SIDS optimally to achieve the full potential catch. We estimate the number of people who could have met their animal protein needs if the fisheries in SIDS were managed to achieve their full potential. To do this, we converted the estimated catch losses in each SIDS into potential food energy, assuming energy content of ~120 cal per 100 g of marine fish landings. Next, we divide the calculated food energy lost by how much food energy a typical person needs per day in Kcal, which is assumed here to be 2 kcal per day or 730 kcal per year.

2.3 Fisheries subsidies in Small Island Developing States

Subsidies have been defined simply as government financial transfers that help reduce the cost of fishing, e.g. fuel subsidies or artificially increase revenues to fishing enterprises, e.g., through price support subsidies (Milazzo, 1998). Subsidies are categorized in this paper into beneficial or 'good', harmful or 'bad' and ambiguous or 'ugly' categories. 'Good' or beneficial subsidies help maintain or enhance the growth of fish stocks through conservation and monitoring of catch rates via control and surveillance measures. Examples of good subsidies are fisheries management programs and fishery

research. Harmful subsidies result in the growth of fishing effort, which can lead to outright destruction of the natural resource. Such subsidies include all forms of capital inputs and infrastructure investments from public sources. 'Ugly' subsidies are ambiguous, and can lead to either decline or growth in fishing effort depending on the context and management effectiveness. An example is vessel buyback or decommissioning programs, which if not designed and implemented such that the industry is caught by surprise, will not guarantee that the subsidies will have a positive effect in terms of overcapacity (Clark *et al.*, 2005; Sumaila *et al.*, 2010).

Sumaila *et al.* (2010) reports on a global fisheries subsidies database that contains information on all maritime countries of the world. We pulled off subsidies data from this database for Small Island Developing States and report them in Table 1. This data is first analyzed on its own and then used to tease out the potential effects of subsidies on overfishing.

2.4 Potential effects of fisheries subsidies on overfishing in Small Island Developing States

We combine data on catch loss with subsidies data to carry out simple regression analysis to help us tease out the effect of subsidies on overfishing. We used the regression analysis to test the following hypothesis (i) high total subsidies means high loss of catch potential; (ii) high levels of bad or harmful subsidies results in high catch loss potential; and (iii) high levels of good subsidies will mean lower levels of catch loss potential.

3 The results

3.1 Potential catch loss in SIDS

All SIDS in our study registered catch losses, ranging from 9% of the potential catch in the case of Solomon Islands to 89% for Guinea-Bissau. As a group, SIDS as a group are currently catching only 48% of the potential catch of the EEZs, with Oceania registering the highest loss at 59% of the potential, followed by Latin America and the Caribbean, Africa and Asia of 48%, 47% and 25%, respectively (Figure 1). In terms of the proportion of fish stocks that are currently classified as overfished, 27 to 90% of the fish stocks in SIDS are overfished, with a total of 60% for all the studied stocks in SIDS. Regionally, the proportion of overfished stocks is highest in Africa (72%) followed by Oceania (68%), Asia (54%) and Latin America and Caribbean (51%) (Figure 1).

Figure 1 in here!

3.2 Food security implications of catch losses in SIDS

Table 1 lists country-level catch losses using the mid-level MSYs from Srinivasan *et al.* (2010) As shown earlier, many island states, where fish has long been a cultural staple, suffer significant losses in catch potential. This loss translates into large losses in potential food energy, which could have been used to feed millions of people in SIDS and around the world. Our calculations indicate that, in total, 1.2 million people could obtain their food energy needs if fisheries in the SIDS were managed more effectively. Countries like Micronesia and Guinea-Bissau register the largest losses in terms of number

of people who could have been supplied their food energy requirements from lost catch potential. The total catch loss for all SIDS in our study is estimated at 737 thousand tones (Table 1).

3.3 Fisheries subsidies in Small Island Developing States

The total, good, bad and ugly subsidies for each SIDS are reported in Table 1. We see from the table that in total SIDS provide an estimated annual subsidy of about $1.44 billion, of which $545, $872 and $28 million are beneficial, harmful and ambiguous subsidies, respectively.

3.4 Potential effects of fisheries subsidies on overfishing in Small Island Developing States

The regression analysis carried out reveals that the hypothesis that (i) high total subsidies results in high levels of catch loss was accepted as the sign of the coefficient of the regression is both in the right direction and significant at the 5% level of confidence ($p<0.05$) (Figure 2); (ii) the higher the level of bad or harmful subsidies provided the higher the potential catch loss was also accepted ($p<0.05$) (3). As expected, the amount of bad subsidies has a stronger relationship with catch loss than in the case of total subsidies. Finally, our third hypothesis that good subsides will result in lower losses in catch potential was rejected at even the 10% confidence level ($p>0.1$) (Figure 4).

Figures 2-3 in here!

4. Discussion and conclusion

We show that overfishing in SIDS is serious, causing large losses in catch and impacts on the socio-economics of these countries. Currently, SIDS have lost an estimated half of their potential catch because of overfishing. The estimated catch loss and proportion of overfished stocks are higher than average from all the countries in these regions. Previous studies suggest that 16-31% of stocks were overfished over 1950-2004 (Froese and Kesner-Reyes; FAO 2009; Srinivasan *et al*. 2010) with an estimated catch loss relative to MSYs of 19%, 14%, 13% and 7% in Africa, Asia, Oceania and South America, respectively (Srinivasan *et al*. 2010). The SIDS have more than double the proportion of overfished stocks than the global estimates and 2-3 times higher catch loss relative to the MSYs than the values from all the countries in each region. Besides causing the loss of nutrient supply to these countries, the large proportion of overfished stocks affects marine biodiversity and potentially alter ecosystem functioning (Worm *et al*. 2006). These may have negative effects on other ecosystem services besides fisheries, e.g., tourism, thus further exacerbating the impacts of overfishing. The SIDS are particularly vulnerable to these impacts because of their strong resource dependency, lack of alternative livelihoods and low adaptive capacity to the impacts (Allison *et al.,* 2009). In particular, it is projected that many of the SIDS are most vulnerable to climate change impacts, partly caused by the negative impacts it has on fisheries productivity (Allison *et al*. 2009; Cheung *et al*. 2010).

Our analysis suggests that an important step to reduce overfishing in SIDS would be to reduce bad subsidies. We show that there is significant and positive relationship between subsidies, bad subsidies specifically, and overfishing in SIDS, which agrees with bioeconomic theory. Thus, reducing bad subsidies is likely to reduce overfishing. However, subsidies explain about 20% of the variation of the catch loss level, while the remaining variance is likely to be dependent on other main overfishing drivers

such as the open access and shared nature of fish stocks, rising fish demand and ineffectiveness of fisheries management measures. Future analysis will evaluate the contribution of other factors to catch loss and overfishing in SIDS. Results from such analysis could help prioritize measures to curtail overfishing problem.

We have demonstrated that ineffective management and overfishing are costing the SIDS highly resulting in the loss of just over 50% of the catch potential in their EEZ. We have also shown that significant amounts of subsidies are provided by governments of SIDS to their fishing sectors, shown to be a key reason for the overfishing currently taking place in Small island Developing States.

Reference list

APEC (2000). Study into the nature and extent of subsidies in the fisheries sector of APEC member economies. PricewaterhouseCoopers Report, No. CTI 07/99T.

Allison, E. H., Perry, A. L., Badjeck, M-C., Adger, W. N., Brown, K., Conway, D., Halls, A. S., Pilling, G. M., Reynolds, J. D., Andrew, N. L. and Dulvy, N. K. (2009). Vulnerability of national economies to the impacts of climate change on fisheries. *Fish and Fisheries* 10: 173-196.

Clark, C.M., Munro, G., and Sumaila, U.R. (2007). Buyback, subsidies, the time consistency problem and the ITQ alternative. *Land Economics*, 83(1), 50-58.

Cheung, W.W.L., Lam, V.W.Y., Sarmiento, J.L., Kearney, K., Watson, R., Zeller, D. and Pauly, D. (2010). Large-scale redistribution of maximum catch potential in the global ocean under climate change. *Global Change Biology*, 16: 24-35.

FAO (1992), 'Marine fisheries and the law of the sea: A decade of change', FAO Fisheries Circular No.853. FAO, (Rome).

FAO (2001), 'Report on the expert consultation on economic incentives and responsible fisheries', Papers presented to the Committee on Fisheries, 24th session, Fisheries FAO Fisheries Report No. 638. Suppl., FAO, (Rome).

FAO (2009). The State of World Fisheries and Aquaculture 2008. The United Nations Food and Agriculture Organization, Rome.

Froese, Rainer & Kathleen Kesner-Reyes (2002). Impact of fishing on the abundance of marine species. ICES Council Meeting Report CM 12/L:12, International Council for the Exploration of the Sea (ICES), Copenhagen, Denmark, 2002. 12:1–15.

Hutchings, J.A. and J.D. Reynolds (2004). Marine fish population collapses: consequences for recovery and extinction risk. *BioScience* 54(4): 297-309.

Myers, R.A., and B. Worm (2003). Rapid worldwide depletion of predatory fish communities. *Nature,* Vol. 432, 280-283.

Pauly, D., V. Christensen, S. Guénette, T.J. Pitcher, U.R. Sumaila, C.J. Walters, R. Watson, and D. Zeller (2002). Towards sustainability in world fisheries. *Nature* 418: 689-695.

Milazzo, M. (1998), 'Subsidies in world fisheries: a re-examination', World Bank Technical Paper, No. 406, Fisheries series, The World Bank., (Washington, DC).

MRAG (2006), 'Fisheries and poverty reduction.' FMSP policy brief 1. MRAG, DFID program. London, UK.

Munro, G., and U.R. Sumaila, (2002). The impact of subsidies upon fisheries management and sustainability: the case of the North Atlantic, *Fish and Fisheries*, 3: 233-250.

OECD (2004). Review of fisheries in OECD countries, Country statistics 2000-2002, Organization for Economic Cooperation and Development, (Paris).

OECD (2005). .Subsidies: a way towards a sustainable fisheries? Policy Brief, Organization for Economic Cooperation and Development, (Paris).

Srinivasan, U., W. Cheung, R. Watson and U.R. Sumaila (2010). Food security implications of global marine catch losses due to overfishing. *Journal of Bioeconomics*, DOI 10.1007/s10818-010-9090-9.

Sumaila, U.R., Khan, Andrew J. Dyck, A., Watson, R., Munro, G., Peter Tyedmers, and Pauly, D. (in press). A bottom-up re-estimation of global fisheries subsidies. *Journal of Bioeconomics*, DOI 10.1007/s10818-010-9091-8.

Sumaila, U.R. and William W.L. Cheung (2009). Vulnerability and Sustainability of Marine Fish Stocks Worldwide: With Emphasis on Fish Stocks of the Commonwealth of Nations. *In* Bourne R and M. Collins (eds.). From hook to plate: The state of marine fisheries – A Commonwealth perspective, 195 210.

World Bank and Food and Agriculture Organization (2008). The Sunken Billions. The Economic Justification for Fisheries Reform. Agriculture and Rural Development Department. The World Bank. Washington DC.

Worm, Boris, Edward B. Barbier, Nicola Beaumont, J. Emmett Duffy, Carl Folke, Benjamin S. Halpern, Jeremy B. C. Jackson, Heike K. Lotze, Fiorenza Micheli, Stephen R. Palumbi, Enric Sala, Kimberley A. Selkoe, John J. Stachowicz & Reg Watson (2006). Impacts of Biodiversity Loss on Ocean Ecosystem Services. *Science* 314:787-790.

Table 1: Annual subsidies & catch data for Small Island Developing States (SIDS) [Sumaila et al. (2010); Srinivasan (2010)]. All amounts are in US$.

Country	Total Subsidies ($ '000)	Good Subsidies ($ '000)	Bad Subsidies ($ '000)	Ugly Subsidies ($ '000)	MSY Catch (tonnes)	Catch (2005 tonnes)	Lost potential catch (tonnes)
Antigua & Barbuda	4,110	612	3,497	0	9,214	2,407	4,316
Bahamas	14,275	11,039	3,236	0	25,680	10,969	7,583
Barbados	880	324	484	73	3,829	161	1,666
Belize	7,881	1,530	6,233	119	40,449	2,663	27,719
Cape Verde	11,222	1,626	9,597	0	43,680	11,770	31,825
Comoros	677	399	137	142	6,381	4,904	948
Cuba	13,886	12,963	923	0	64,029	17,847	38,319
Dominica	7,262	469	6,758	34	6,522	1,148	4,465
Dominican Republic	7,464	7,344	120	0	22,878	9,353	12,128
Fiji	39,828	13,327	25,053	1,448	41,697	13,236	30,478
Grenada	5,401	740	4,662	0	6,109	868	3,590
Guinea-Bissau	4,394	1,182	3,155	57	171,382	9,933	153,052
Guyana	54,538	23,200	29,377	1,960	37,613	49,381	3,971
Haiti	4,404	3,762	643	0	7,769	7,900	870
Jamaica	10,695	4,194	6,197	303	54,357	12,696	27,834
Kiribati	23,533	6,928	16,605	0	59,597	20,405	35,657
Maldives	65,167	49,217	15,950	0	23,371	20,741	3,057
Marshall Islands	72,113	51,213	20,899	0	65,055	10,738	38,302
Mauritius	2,226	799	1,428	0	34,517	43,476	5,688
Micronesia	170,081	41,885	128,195	0	167,116	23,943	131,085
Nauru	166	49	117	0	10,975	1,976	8,979
Palau	1,497	472	1,025	0	37,530	5,267	25,747
Papua New Guinea	662,014	216,372	427,468	18,174	143,387	292,139	18,830
Samoa	7,329	4,728	2,243	359	5,211	229	4,490
Sao Tome & Principe	740	163	554	23	12,933	5,182	7,050
Seychelles	28,646	5,131	23,243	271	33,610	32,905	11,759
Singapore	316	316	0	0	67,202	15,718	18,188
Solomon Islands	34,983	23,053	8,711	3,219	68,521	96,509	6,128
St. Kitts & Nevis	1,080	108	973	0	8,692	450	5,638
St. Lucia	4,038	1,274	2,726	38	9,613	1,409	4,689
St. Vincent & Grenadines	5,291	1,766	3,413	112	6,316	51	3,519
Suriname	15,829	9,625	5,032	1,172	32,094	28,041	10,675
Timor Leste	0	0	0	0	28,481	354	10,174
Tonga	7,156	3,155	4,002	0	8,285	539	5,832
Trinidad & Tobago	11,483	3,477	8,006	0	29,931	3,184	16,839
Tuvalu	0	0	0	0	15,619	2,303	12,991
Vanuatu	143,987	42,758	101,229	0	11,134	11,780	2,970
Total	**1,444,592**	**545,200**	**871,891**	**27,504**	**1,420,779**	**772,575**	**737,051**

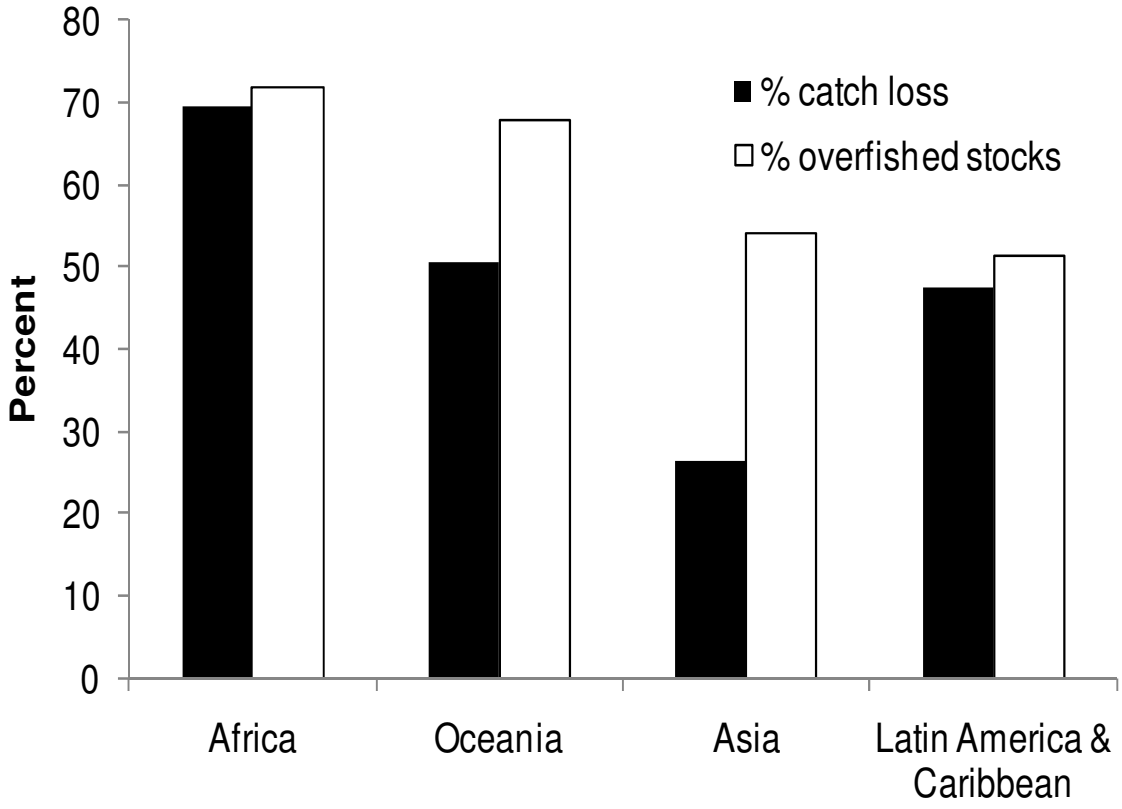

Figure 1: Percentage of catch loss and overfished stocks in Small Island States by region.

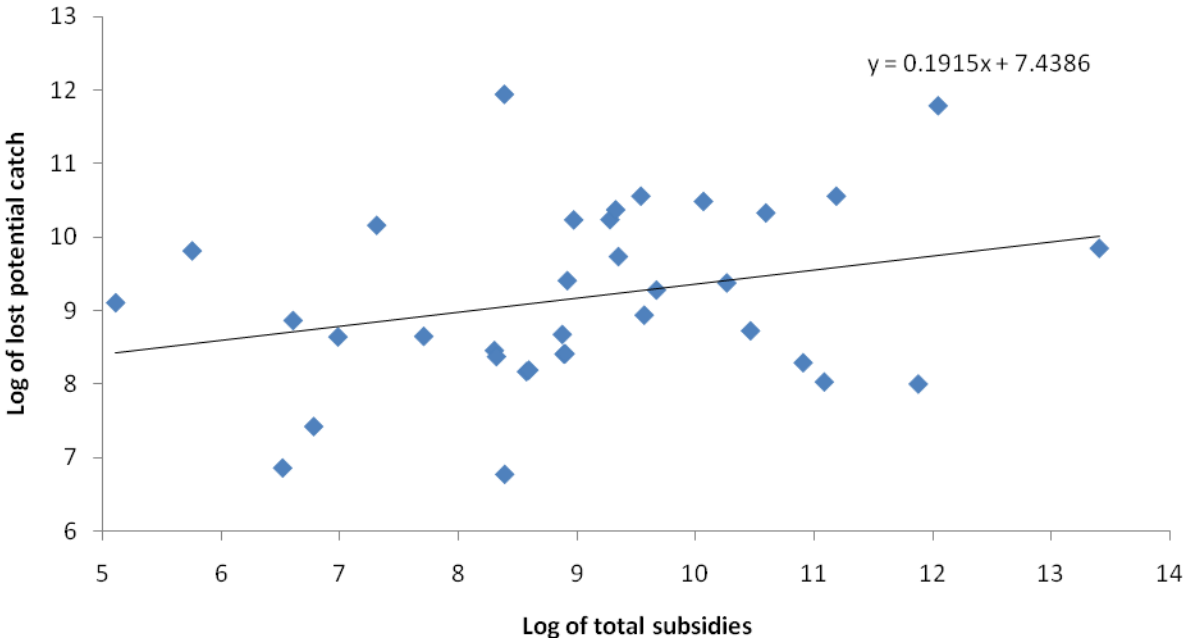

Figure 2: Demonstrates the relation between total subsidies and the potential catch loss in SIDs.

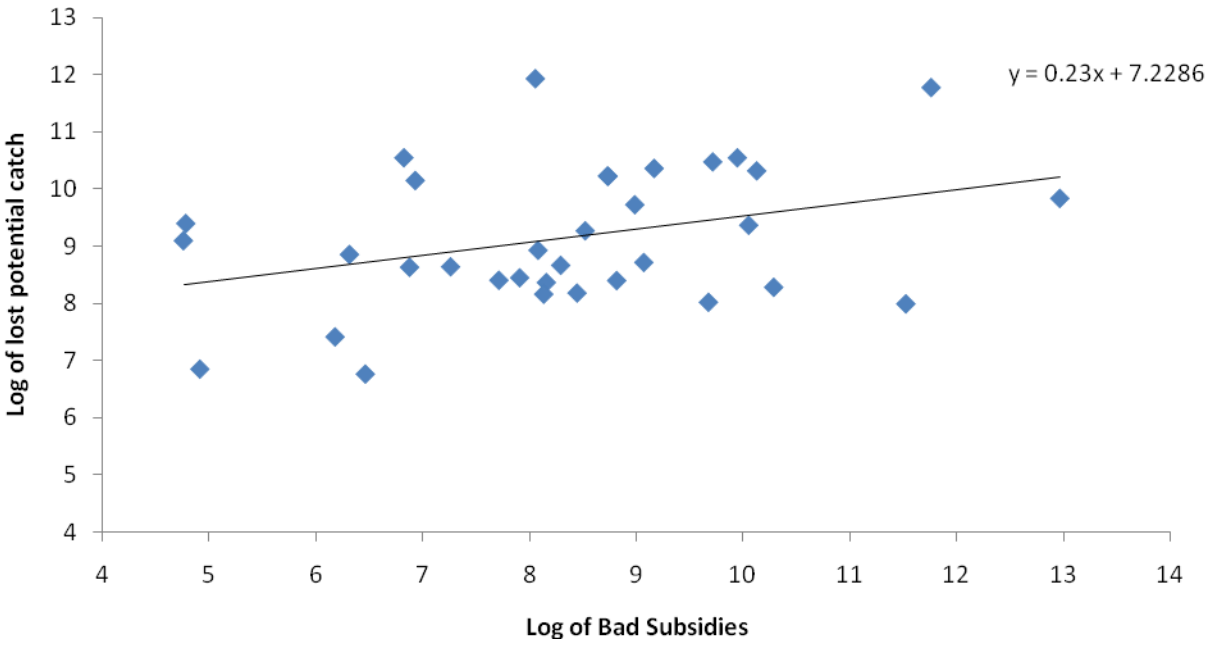

Figure 3: Demonstrates the relationship between harmful or bad subsidies and the potential catch loss in SIDs.

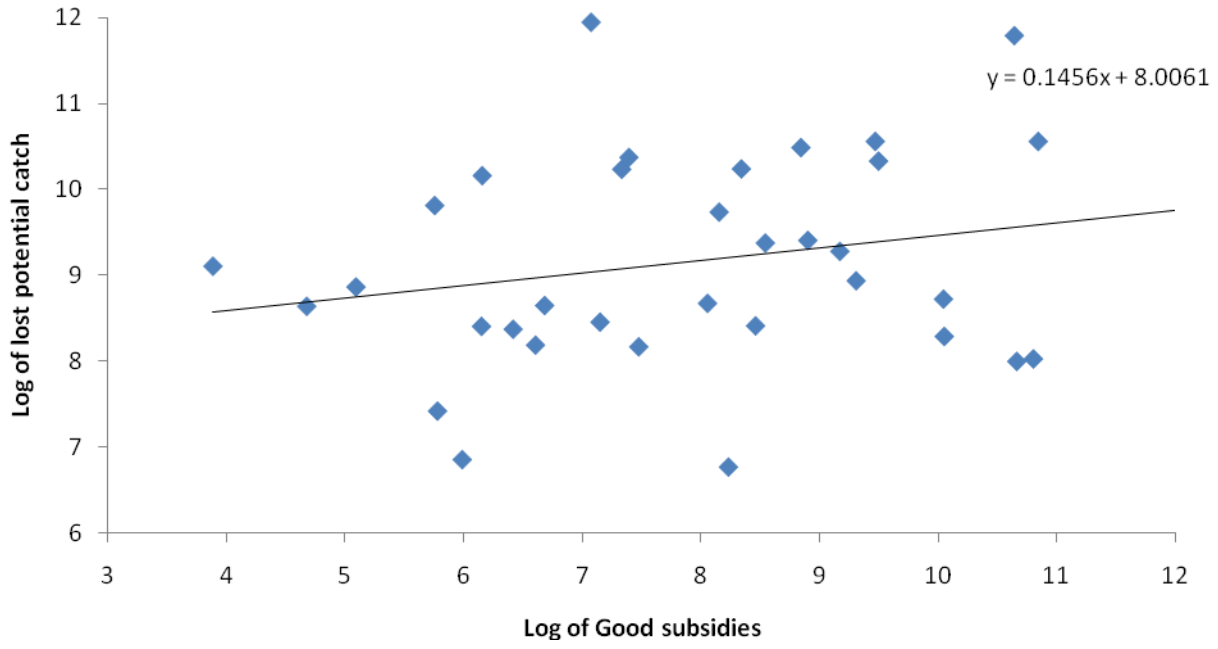

Figure 4: Demonstrates the relationship between beneficial or good subsidies and the potential catch loss in SIDs.