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Review

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Application of the DPSIR Framework to Coastal and Marine Fisheries Management in Kenya

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Abstract – Natural resource management frameworks are important in generating information that promotes the development of appropriate policies and regulation for effective management and utilization of different aspects of ecosystems. The Drivers-Pressure-State-Impact and Response (DPSIR) framework is one of such frameworks which has been widely applied globally in assessing, addressing and communicating with regard to environmental problems. This framework provides a nexus between the causes of environmental problems and the resultant pressures, associated impacts and responses needed to resolve and manage specific environmental issues and challenges. Based on improved management evidence for natural resources enabled by the application of the DPSIR framework globally, this paper is a review of the application of the framework in the management of coastal and marine fisheries resources in Kenya. Findings indicate that there exists a limited number of studies which have adopted the DPSIR framework approach in Kenya, and these are mainly focused on terrestrial ecosystems. However, coastal and marine resources have been well studied in Kenya using different methodological approaches that have given insights into the conditions of resources. This review, therefore, analyzed these studies to understand drivers, pressures, states, impacts and responses in relation to coastal and marine fisheries resources in Kenya. The main drivers observed were a high population growth rate of 3.7% as well as a high dependency rate on natural resources of 74% and 58% in Ngomeni and Kipini fishing areas of north coast Kenya, respectively. There is also a lack of understanding regarding the potential of the DPSIR framework to effectively manage coastal and marine fisheries resources, particularly in the context of sub-Saharan Africa, taking Kenya as a case study. This may result in the development of fisheries regulations that are not holistic in their approach, and therefore, ineffective from a management perspective. Within this context, this paper provides a discourse on how the DPSIR framework may enhance coastal and marine fisheries resources management in Kenya.

Key words – DPSIR framework, coastal and marine fisheries, management framework, Kenya

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1. Introduction

Since its inception, the Driver-Pressure-State-Impact-Response (DPSIR) framework has attracted varied responses. The framework was developed in the 1990s as a tool for environmental assessment and to demonstrate the relationship between the environment and human systems in the form of cause and associated consequences (Kristensen 2004; Carr et al. 2007; Mimidis et al. 2017). In the mid-1990s, the framework was adopted by the European Environment Agency (EEA) and it then became widely recognized among researchers and policy makers (Carr et al. 2007; Svarstad et al. 2008). Mattas et al. (2014) consider the DPSIR framework as an appropriate and simple tool to address major environmental problems and, thus, to help with the decision making process in policy and the regulatory enforcement. As a tool for environmental management, the DPSIR framework is often applied by natural scientists and has proved to be useful in identifying drivers of environmental degradation and the associated institutional and policy responses (Lan et al. 2014).

Despite its value and potential for environmental assessment and management, the DPSIR framework has been criticized

for possessing several weaknesses (Svarstad 2008; Carr et al. 2007). The framework is not flexible and assumes a unidirectional functioning of established indicators (Carr et al. 2007). Flexibility is viewed from the perspective of possible responses between two elements of the framework such as drivers and pressure. For example, if pressure on natural resources is extremely high as a result of intense human driving forces, then responses may be initiated at the pressure level to minimize the intensity of the driving forces. Contrary to this perspective, the responses in the DPSIR framework are generated at the end of the cycle. Therefore, even though the framework illustrates the cause-effect relationship, Svarstad (2008) is of the view that the framework has failed to establish the same relationship between the elements. This limitation is acknowledged by Stavros et al. (2016) in their work which noted that some pressure results in instant impact, while some impacts require an immediate response. In such cases, therefore, the framework tends to be rigid and has been described as a means of disseminating information rather than being an analytical tool (Carr et al. 2007).

Recent studies have begun to view the DPSIR framework in a different light and not think of it as merely a reporting tool (Kagalou et at. 2012; Gari et al. 2018; Vannevel 2018). This perception of the DPSIR framework as simply a reporting tool is due to a lack of common understanding and based on an interpretation of the framework where quantitative approaches are applied (Elliott et al. 2017; Vannevel 2018). For this reason, Elliott et al. (2017) suggested improvements and modifications of the DPSIR framework to include elements which would capture the complex marine environment interactions between ecological structure and functioning, physico-chemical processes and socio-economic systems. This gave rise to the formulation of the DAPSI(W)R(M) (pronounced *dap-see-worm*) framework for marine management, in which the Drivers of basic human needs require Activities which lead to Pressures. The Pressures then became the apparatuses of State conversion on the natural system, thereby leading to Impacts on human welfare and ecosystem disturbances. The combination of these then requires Response as Measures. Nonetheless, quantitative analyses have been used to draw conclusions on the quality of water systems. Agriculutre, sewage, land use change and urban wastes, for example, have been regarded as important drivers for the poor quality of water systems (Kagalou et al. 2012; Gari et al. 2018).

The qualitative and quantitative approach of the DPSIR framework is vital for decision makers in enforcing environmental regulations. Based on the information generated through various studies, specific natural resource regulations are recommended, especially those involving public participation in managing environmental issues such as water pollution (Islam et al. 2012; Mattas et al. 2014). After reviewing two decades of lessons learned from the use of the DPSIR framework, Patrício et al. (2016) suggested that the framework is indeed important as a unifying tool in assessing linkages in human presure with coastal and marine ecosystems. In this regard, the DPSIR framework is best placed to identify important drivers, pressure and the state of tropical artisanal coastal and marine fisheries resources such as those with regard to Kenya. Despite the long term existence of the DPSIR framework, there is generally less observed application of the framework in the assessment of coastal and marine resources (Patrício et al. 2016). This is particularly the case with regard to the situation in Kenya where this framework has not been applied in most environmental-related studies.

Coastal and marine fisheries resources in Kenya experience myriad management challenges. This is because of the high dependence level of artisanal fishing communities on fisheries resources as well as the inability of these communities to access offshore resources due to a lack of appropriate fishing techniques (GOK 2014). A good example is the Malindi-Ungwana Bay bottom trawl prawn fishery activity in the north coast Kenya which has, over the course of four decades, resulted in the degradation of bottom habitats as well as decreased target and bycatch species (Munga et al. 2012b, 2014a). A management plan was developed to address the issue of over-exploitation of prawns due to increased efforts by bottom trawlers (GOK 2015b). However, the management plan was not holistic in that it did not include or adopt an ecological approach to fisheries (EAF) management. This was due to lack of data on ecological, biological, climate, and upstream land use characteristics as well as a failure by the management plan to integrate the impacts caused by artisanal prawn fishing on important nearshore habitats. The management plan was formulated without adequate baseline support information and research planning, in addition to the absence of a multi-sectoral committee for its implementation.

Before it conducted its review, the management plan failed to adhere to the EAF principles of maintaining ecosystem integrity, improving human-wellbeing, application of the precautionary approach for adaptive management, full stakeholder participation, and improvement of research to better understand all the components of the ecosystem (FAO 2003, 2005). The revised

prawn fishery management plan follows the EAF approach with a better awareness of the ecosystem, human-wellbeing, as well as performing continuous research work to garner more scientific information for adaptive management purposes. High fishing pressure has also been reported regarding inshore artisanal fishery along the entire Kenya coast due to ever increasing fishing efforts (GOK 2014, 2016) that have resulted in reduced catches and degradation of habitats such as corals and mangroves (Fondo et al. 2014). In addition, the effects of climate change may further impact artisanal coastal and marine fisheries resources (Dzoga et al. 2018). Consequently, proper assessment of these resources using appropriate tools is required to ensure sustainable management.

This paper, therefore, presents a review of the literature to illustrate the application of the DPSIR framework in the assessment of coastal and marine fisheries management in Kenya. The overall objective is to analyze the application of the different elements of the DPSIR framework within the Kenyan context and establish the extent to which it can be used as a tool for the effective management of coastal and marine resources. Furthermore, this review intends to identify existing gaps or flaws in order to recommend better approaches for the management of coastal and marine fisheries resources in Kenya and the Western Indian Ocean (WIO) region at large.

2. Methods

This paper is based on information compiled through an appraisal and review of literature ranging from published scientific journal articles and grey literature on the potential of the DPSIR framework in managing natural resources, particularly coastal and marine fisheries. The review involved a thorough desktop search from Google Scholar search engine using key searching words including DPSIR, DPS, PSR, natural resource management framework, fisheries management framework, coastal, and marine fisheries. The initial search adopted a global perspective regarding the framework application, then focused on coastal and marine fisheries publications. Due to the lack of literature on the application of the DPSIR framework in the management of artisanal coastal and marine fisheries in Kenya, a wider review was conducted based on existing studies with different methodological approaches on the state of fisheries along the Kenya coast with the aim of identifying the Drivers-Pressure-State-Impact-Response within the DPSIR framework. The resultant existing literature sources were selected and carefully analyzed to include the relevant peer reviewed sceintific articles and grey literature suitable for this study. All literature sources referred to were acknowledged and appropriately cited. In total, 49 literature sources were reviewed for this study, and out of which 22 had a global perspective while 27 were appropriate for the situation in Kenya.

3. The DPSIR Framework and Coastal and Marine Fisheries Management

The DPSIR framework is commonly known as a tool for assessing causal links among environmental problems and structuring them into five main elements, namely: Drivers, Pressure, State, Impacts and Response (see Fig. 1) (Kristensen 2004). In general, drivers comprise the needs of a society that lead to activities to achieve them (Kristensen 2004; Patrício et al. 2016). These activities are termed as pressure and signify the force exerted over natural resources. Kristensen (2004) further described the change in quality of natural resources due to exerted pressure as the state of the resources. The impact is the resultant effect on the quality of the natural resources on the socio-economic life of humanity. Ultimately, measures developed to control these effects are known as responses.

Though the framework appears simple in application, studies have increasingly interpreted these elements differently and this has caused some misunderstanding at the decision making level (Svarstad et al. 2008; Oesterwind et al. 2016). Consequently, Oesterwind et al. (2016) suggested a common understanding and interpretation of the five elements in coastal and marine studies. They defined Drivers as a cause of a phenomenon instead of a societal need; Pressure as human activities or natural processes affecting the ecosystem; State as the actual condition of the ecosystem; Impact as the resultant effects of ecosystem change on human and natural resources; and Responses as all actions undertaken to control the perceived effects. Lewison et al. (2016) reviewed literature in order to demonstrate the application of DPSIR in formulating empirical research on coastal systems. The study illustrated that DPSIR can be quantitatively applied in conducting assessments of coastal systems. As a result, a quantitative way of applying DPSIR for coastal studies was proposed. The quantitative approach of the DPSIR framework has been emphasized and improved by recent studies (Elliott et al. 2017; Mimidis et al. 2017; Gari et al. 2018). Elliott et al. (2017) introduced a multicycle of DPSIR elements to overcome

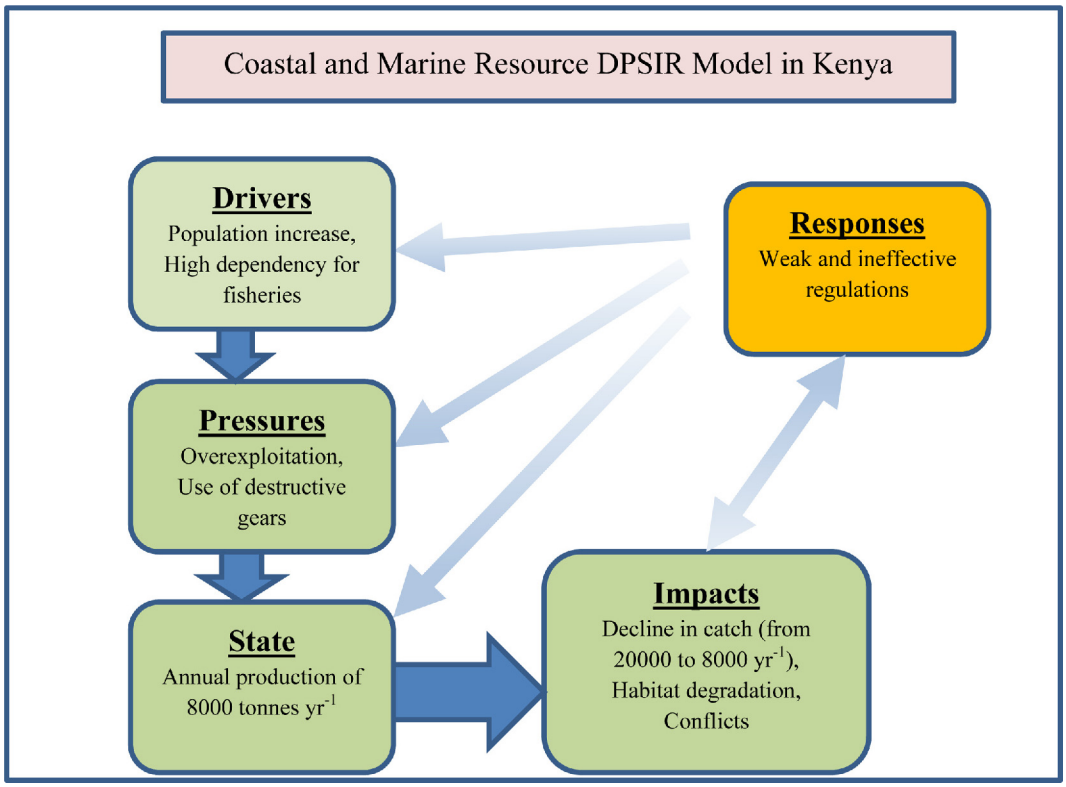

Fig. 1. DPSIR assessment framework (modified from Kristensen, 2004)

the unidirectional relationship in a human ecosystem. The cycles capture different types of drivers with their respective pressure, state and impacts affecting human welfare. The response element interacts with all the cycles and thus provides an opportunity for an immidiate response to the drivers. This way, each driver can be quantitatively analysed in a separate manner.

This is observed in Gari et al. (2018) who applied the multicycle approach quantitatively to analyse water quality in Colombia. The study compiled quantities of bacteria (MPN/ml), organic (%), nutrients (mg/l), and mercury (mg/kg) contamination in the water bodies as pressure elements. The levels of contamination were compared against the standard levels required for human consumption to establish the impact. The study noted that socio-economic activities affected the quality of Dagua River in Colombia. A similar quantitative approach also established high concentrations of nutrients such as nitrates ranging between 0.1 and 2.6 mg/L as well as high eutrophication levels indicated by the presence of chlorophyll-a ranging between 0.54 and 6.14 mg/m^3 (Kagalou et al. 2012). Findings from these studies, therefore, confirm that a quantitative approach provides clear threshold limits which can be useful to decision makers. However, the DPSIR framework is not specific on matrices to be used for a quantitative approach. Thus the unit of measurement depends on the nature and focus of study.

Coastal and marine resources are complex in terms of interaction - especially those in developing tropical countries. Thus, there is a need for a common framework that can integrate the complexity in nature for easier and sustainable management of natural resources (Ojeda-Martı´nez et al. 2008). For over two decades, researchers have made efforts to develop such frameworks without success (Patrício et al. 2016). For example, the Ecosystem Approach to Fisheries (EAF) Management Framework was developed to ensure a holistic view of the ecosystem where human actors are an integral part in its development and application, thereby ensuring that human needs are achieved while maintaining the health of natural resources (Gracia et al. 2003). However, Cowan et al. (2012) noted that the EAF has neither succeeded nor failed in ensuring a holistic management to coastal and marine ecosystems and so the development of a framework that would contribute to the effective and sustainable management of the associated resources is required. USAID

(2013) suggested the DPSIR framework as a framework for reporting the state of coastal and marine resources. Recent studies have noted the importance of the DPSIR framework as a tool for communicating about and managing coastal and marine ecosystems (Patrício et al. 2016; Oesterwind et al. 2016; Lewison et al. 2016). Therefore, the DPSIR framework is currently widely recomended in the management of coastal and marine systems.

4. Contextualising DPSIR Framework on Coastal and Marine Fisheries Management in Kenya

While the DPSIR framework has gained much recognition globally, there are still very few studies that have adopted this approach in Kenya. Wangai et al. (2017) applied the DPSIR framework in identifying and qualifying indicators for the nexus between cultural ecosystem services and human wellbeing. However, the focus of the study was entirely based on establishing how human actors influence environmental change and how institutional frameworks and processes are structured to respond to these changes. Mangi et al. (2007) on the other hand, applied the DPSIR framework to understand the challenges of reef fisheries management in Kenya. This study recommended appropriate indicators that are useful in assessing reef fisheries and therefore their management (see Table 1). In view of this, the current paper relies on the stated indicators and, to some extent, it includes other indicators that fit in the definition of DPSIR elements so as to broaden the understanding of environmental problems and the resultant consequences of coastal and marine fisheries management along the Kenya coast.

Coastal and marine fisheries in Kenya have been well studied (Munga et al. 2014b; Okemwa et al. 2015; Osuka et al. 2016). While these authors did not adopt the DPSIR framework approach to articulate coastal and marine fisheries management issues, they made significant contributions in understanding the status, pressure and impacts of the resources. The methodological approaches of coastal and marine studies focused mostly on quantifying and describing various aspects of fisheries resources including abundance, species distribution and composition (McClanahan et al. 1999; Munga et al. 2012a; Okemwa et al. 2015). On the other hand, the DPSIR framework approach does not fully generate primary information on its own. For instance, to establish the water quality of a river, there is need to compare levels of contamination (primary information) with the standard required (secondary information) for human consumption for different physico-chemical parameters (Gari et al. 2018). Furthermore, secondary data are benchmarks for future assessment scenerios. Therefore, despite the lack of a full DPSIR framework approach on coastal and marine fisheries resources in Kenya, the existing studies are critical in harmonizing the frameworks' elements.

This is where the DPSIR framework provides a unifying platform by describing and quantifying the driving factors as the first step for comprehending the issues of coastal and marine resources as well as their management. In this review, therefore, the framework was applied to adopt a rational approach to the identification of driving factors in isolated studies with different methodological approaches in order to enhance coherence regarding the management of coastal and marine reasources in Kenya. Obura (2001) characterized the coastal and marine resources of Kenya and noted that human population growth is a significant factor that increases

Table 1. DPSIR indicators of reef fisheries management along the Kenya coast (Mangi et al. 2007)

Drivers		Pressures		State		Impact		Responses	
Indicators	Unit of measurement	Indicators	Unit of measurement	Indicators	Unit of measurement	Indicators	Unit of measurement	Indicators	Unit of measurement
Population	% increase	Increase of number of fishers	No./km^2	Fish abundance	Biomas (kg/ha)	Decrease in fish catch	Catch per nuit effort (kg/fisher)	Legislations	No. of parlimentary acts
Unemployment	%	Over-exploitation	Trends in catch (kg/yr)	Live coral cover	% covercomplexity score	Destruction of livelihoods	% dependence on coral resources	Planning regulations	% of territorial water under protection
Cultural tradition	(number of activities)	Destructive fishing gears	No./month	Sea urchins population	Density (No./m^2)	Conflicts increase	No. excluded, No. of conflicts		
Poverty	% of population below poverty line			Change due to climate variability	% cover, % loss				

the demand for fisheries resources. The coastal population is growing at a rate of 3.7% annually and exerts a significant pressure on the fisheries resources (Obura 2001). In a different approach, Kitheka (2002), described a high dependence on natural resources as an important factor that increases the demand for fisheries resources as well. The fishing areas of Ngomeni and Kipini in the north coast of Kenya have been depicted as having high dependency levels on artisanal fisheries resources -74% and 58%, respectively (Dzoga et al. 2019). Population increase as well as high dependence levels on coastal and marine fisheries constitute the main driving factors for fisheries resources in Kenya. These indicators, being the the main driving factors, need to be linked all through the framework so as to generate approriate information for appropriate responses.

The second component of the DPSIR framework measures the pressure exerted by driving factors. This is essential for providing benchmarks upon which decisions are based on. Some studies have adequately explained the element of pressure on coastal and marine fisheries resources in Kenya (Fondo et al. 2014; Aloo et al. 2014). Fondo et al. (2014) for example, documented cases of overexploitation of coastal and marine fisheries in Kenya based on yield per unit area. According to this author, the yield of reef fisheries in Kenya is sustainable between 2 and 4 tons $km^{-2} year^{-1}$. However, the extraction of these resources along the Kenya coast lies between the unsustainable annual yield of between 5.07 and 12.9 tons km^{-2} with a mean of 8.8 tons km^{-2} $year^{-1}$ thus exceeding the threshold limit (Fondo et al. 2014). Samoilys et al. (2017) confirmed the issue of overexploitation by acknowledging the high productivity of reef fisheries that exceeds the recommended range. Further, the use of destructive fishing gears in artisanal fishery has amplified the pressure exerted on these resources. The use of prohibited fishing gears such as beach seines and monofilament gill nets have resulted in the landing of large quantities of immature and small-sized individuals in this fishery (Fondo et al. 2014; Munga et al. 2014b; Osuka et al. 2016). Reverting to the framework, the link between drivers and pressure with regard to the coastal and marine fisheries in Kenya has been well established. For instance, the increasing human population in the coastal region may have resulted in a higher demand for fisheries resources and, therefore, has significantly contributed to the overexploitation of the fisheries resources. This link between the two elements generates the required information useful for the management of fisheries resources.

In this review, we defined the state of fisheries as the actual quantification and characteristics in various habitats or the threshold limits of exploitation. These quantifications and thresholds of fisheries resources provide the baseline information where the extent of impacts on the resources can be measured by the framework. With this perspective therefore, the overall annual production of coastal and marine fisheries in Kenya has been recently estimated to be slightly more than 20,000 tons annually (GOK 2015a). Previously, there had been under-reporting of the artisanal catches at about 9000 tons annually (Oduor 1984; Aloo et al. 2014). Recent fish stock assessment studies on five commercial small and medium pelagic fish species: *Sphyraena jello*, *S. obtusata*, *S. flavicauda*, *Rastrelligar kanagurta* and *Hemiramphus far* indicated relatively high fishing total mortality (Z) of between 1.23 and 3.90 depending on species, and a total steady state biomass of 964.7 tons annually (Munga et al. 2015) with an indication of signs of inshore overfishing. Furthermore, this study indicated that only the species *Hemiramphus far* recorded a lower F_{CURR} than F_{MSY} that is indicative of optimal fishing compared to higher values of F_{CURR} than F_{MSY} for the rest of the species indicating potentially high fishing prerssure. These studies, however, have provided quantification values for awareness and management purposes but thus far have failed to describe the level of impacts on the fisheries resources. The DPSIR framework harmonizes this by providing a common platform where the baseline information of coastal and marine fisheries may be used to assess the extent of impacts associated within a particular study.

Some studies have, however, qualitatively confirmed the existence of localised decline of coastal and marine resources in various parts of the Kenya coast over time. For example, Fondo et al. (2014) showed a decline in reef fish catches in 1998 in the southern coast of Kenya while Osuka et al. (2016) indicated the decline of the same resources within the same period in the north coast of Kenya. This may be attributed to habitat degradation such as loss of mangrove cover, sea grass and corals with an impact on fisheries production (Fondo et al. 2014). The lack of baseline data and information on the initial status of these resources in the past makes it difficult to assess the current status of these resources. Observed conflicts between artisanal fishery and the semi-industrial bottom trawl prawn fishery signify more impacts on fisheries. Munga et al. (2014a) recorded a similarity in catch composition between the two fishery sub-sectors and this is highly likely to be the root cause of fisheries resource-

use conflicts. Further, Munga et al. (2013) confirmed that there exists differences in prawn biomass with increases in depth and distance offshore for the semi-industrial bottom trawl prawn fishery in Malindi-Ungwana Bay. Therefore, the impacts on the coastal and marine fisheries in Kenya may be represented by the decline in catches, habitat degradation, and conflicts among artisanal fishers in the sector. It is important to note that the decline in catches may as well be as a result of insufficient exploitation of inshore marine resources due to the use of traditional fishing methods that characterize the activities of artisanal fishers.

Kenya has adopted several regulative and legislative measures to manage the coastal and marine fisheries that have been described as good instruments in providing sustainable fisheries management (Hoof and Steins 2017). The Prawn Fishery Management Plan (2010), for example, is a key management tool for fisheries and particularly for the exploitation of the penaeid prawns in the Malindi-Ungwana Bay, north coast Kenya. To some extent the plan has promoted co-management of fisheries resources in the area directly involving the local resource users, private trawler companies, other stakeholders and the government (GOK 2007). This co-management initiative ensures enforcement and compliance of regulations as well as collection of artisanal catch data for adaptive management recommendations. Fisheries co-mangement initiative existed since 2006 (GOK 2012) before the plan was effected. Therefore, fisheries management was further strengthened. In addition to adopting the co-management initiative, the plan has established use zones for exploitation of fisheries resources in the bay mainly to control the fishing pressure as well as to avoid resource-use conflicts. All fishing grounds below 3 nautical miles are strictly for artisanal use. While all fishing grounds beyond 3 nautical miles are available for semi-industrial trawling and with trawling activities prohibited during the night hours from 6 PM in the evening (GOK 2010). To a great extent, the zonation of fishing grounds has reduced conflicts between the semi-industrial trawlers and artisanal fishers. However, the possibility of ecological degradation needs to be investigated (Hoof and Steins 2017). This is mainly because of poor enforcement of fisheries regulations as well as low compliance by the artisanal fishers (Hoof and Steins 2017). Because of the inadequate implementation of the National Oceans and Fisheries Policy, Prawn Fisheries Management Plan, and the Integrated Coastal Zone Management policy (GOK 2008, 2010, 2013), artisanal fisheries resources along the entire Kenyan coast will still experience much exploitation and various management issues.

These management responses may have been developed based on incoherent frameworks of studies that focused on specific aspects of ecosystems. Consequently, the responses are characterized by a lack of commitment in implementation and enforcement (Ruwa 2006; Hoof and Steins 2017). In addition, the fisheries policies are developed with no consideration regarding economic, social, biological, and environmental sustainability; thus encouraging conflicts among and between fishing communities (Ruwa 2006). It is important to note that the ineffectiveness of coastal and marine responses could be a result of information generated from non-uniform study methods that failed to link all aspects of the ecosystem. The effective identification of coastal and marine fisheries issues as well as their management can be achieved by adopting the DPSIR framework approach. In this review, the DPSIR framework has contextualized the coastal and marine fisheries issues into 5 elements and thus provides a common platform to formulate rational responses. Drawing from this review, the fisheries management bodies in Kenya may need to revise and improve fisheries regulations and policies to enhance effective management. The design of the regulatory instrunments has to harmonize the drivers, pressure, state and impacts to achieve a rational response. This review has identified these elements by applying the DPSIR framework and thus serves to help in providing crucial facts needed in enhancing the management of coastal and marine resources in Kenya (Fig. 1).

5. Summary and Conclusion

Quantitative application of the DPSIR framework is useful in identifying the root causes of natural resource issues. As observed in this review, drivers of poor quality in Colombia waters were linked to human activities such as agriculture and mining. This approach, however, does not suggest specific parameters and matrices that may be uniform across all studies. Parameters, units, and matrices to be used depend on the nature of the study. The strength of the DPSIR approach lies with its ability to link cause-effect relationships. Therefore, responses may be logically developed in the management of coastal and marine resources.

DPSIR framework studies are limited in Kenya. The scantiness of the framework approach studies may be low as a single study as observed in this review for coastal and marine resources. In addition to other types of methodological approaches, the DPSIR framework may also be useful in

visualizing the root causes of issues related to coastal and marine reources in Kenya. This approach may strengthen responses to identify natural resource problems.

The DPSIR framework clearly provides a unifying platform where every component in an ecosystem is taken into consideration. The main flaw regarding effective fisheries management in Kenya is the lack of identification and analysis of core drivers of coastal and marine fisheries issues. This review has clearly illustrated this flaw which needs to be addressed in future studies. In addition to the indicators by Mangi et al. (2007), this review has also identified the need to include natural resource dependance level and habitat degradation as important indicators when conducting a DPSIR analysis in fisheries reources. Future studies of coastal and marine fisheries need to include the DPSIR methodological approach so as to develop and enforce policies and regulations that are inclusive with regard to all aspects of the system.

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