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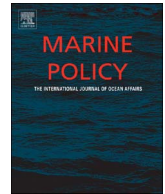
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## The global information system on small-scale fisheries (ISSF): A crowdsourced knowledge platform

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### ABSTRACT

Information about small-scale fisheries (SSF) is often scarce and scattered. This is partly due to insufficient attention on this sector, whose contribution to society is often assumed to be negligible. It also results from SSF being highly diverse, with complex patterns of harvest and post-harvest activities taking place in a wide range of aquatic environments and often in remote areas. Existing fisheries information systems fail to fully capture the characteristics and essence of SSF, resulting in a lack of integrated and up-to-date data, which further marginalizes the sector in policymaking and governance. To help rectify the situation, the Too Big To Ignore project developed the Information System on Small-scale Fisheries (ISSF), a Web-based, open data portal to collect and disseminate knowledge on various aspects of SSF. This paper describes the conception of ISSF and its key features, and presents some results extracted from the analysis of ISSF data, illustrating the importance of such a global database on SSF.

### 1. Introduction

As the main intergovernmental organization responsible for global fisheries, the Food and Agriculture Organization (FAO) of the United Nations (UN) regularly reports estimates about fisheries production and values, fish trade, fishing vessels, and employment. Those data are mostly based on official statistics that FAO gathers from member states using their data collection system, as well as from technical studies that they commission. For instance, in their most authoritative publication series, the 'State of the World Fisheries and Aquaculture', FAO suggested that, in 2008, about 20% of the world's population relied on fish as their main source of protein, and at least 135 million people depended on fishing for their livelihoods [1]. The subsequent edition of this report [2] stated that, of about 120 million full-time and part-time fishers and fish workers, more than 90% were small-scale [2]. Working in partnership with the WorldFish Center and the World Bank's Global Program on Fisheries, FAO also contributed to other estimates, including the Gross Domestic Product (GDP) contribution from all capture fisheries, such as harvest and post-harvest activities (about \$274 billion, representing less than 1% of the total global GDP in 2007) [3]. This report also recognized the critical role that women play throughout the value chain of both small- and large-scale fisheries,

constituting about 47% of the total workforce and are mainly involved in post-harvest activities such as processing and marketing.

Given that about 90–95% of the world's small-scale fisheries (SSF) catches are destined for human consumption [3], and recognizing their contributions to local economies, better mechanisms and data management structures are required to collect and manage information about SSF. The need for such an information system, which could ideally support decision-making on SSF management, inform good governance, and promote sustainable development in consideration of the socio-economic importance of SSF, is particularly emphasized in the 'Voluntary Guidelines for Securing Sustainable Small-Scale Fisheries in the Context of Food Security and Poverty Eradication' (SSF Guidelines), endorsed by the FAO Committee on Fisheries in June 2014. Acknowledging the specificities of SSF, the SSF Guidelines recommend that member states report gender-disaggregated data in their official statistics and that the development of information systems takes into consideration the poor data availability associated with the majority of SSF in the world [4].

Developing an information system that best captures the essence of SSF, while recognizing the data limitations about this sector, is a major challenge. Existing fisheries information systems are designed mainly to serve data gleaned and summarized from other existing sources. The

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primary goal of these information systems is to support regional, national, and sometimes international fisheries management. Examples of these include the US Fisheries Information System (FIS) by the National Oceanic and Atmospheric Administration (NOAA), the *Système d'Informations Halieutiques* (SIH) by IFREMER [5], and the UN Fisheries Global Information System (FIGIS) by FAO. These information systems tend to focus on large-scale, industrial fisheries data in order to comply with standard reporting practices set within a particular country, and as part of the reporting from countries to regional governing bodies (e.g. the European Union) or to intergovernmental organizations like FAO. For example, FAO fisheries statistics are normally presented as aggregated data at the country level. Landings and values from all capture fisheries, whether large-scale or small-scale, are reported together. It is only recently that FAO has attempted to highlight the role of SSF in the economy and its value to society at large. Yet, information about SSF remains scanty, nebulous, and outdated.

One of the main reasons for the lack of national level SSF data is related to the nature of SSF. SSF involve a large number of people with fishing activities covering a wide geographical range. These fishing activities often occur in remote areas outside the mainstream economy, causing them to be frequently missed by traditional sampling methods. The diversity in fishing gears, techniques, target species, landing sites, and utilization of catches is well recognized [6–8], and the complex, dynamic, and evolving nature of SSF [9] makes it difficult firstly to define what SSF are and then obtain accurate information about them. However, some attempts have already been made to differentiate fisheries data into large-scale and small-scale. For instance, Thompson and FAO [10] conducted one of the earliest studies comparing the relative benefits from these two sectors using various indicators such as jobs, fuel consumption, and discards. Their data showed that SSF scored better than large-scale fisheries in all aspects. Their study prompted Pauly [11] to update these data with additional research, concluding that priorities for fisheries development have been largely misplaced. Indeed, conventional approaches of reporting aggregated fisheries data across sectors have seriously disadvantaged SSF and downplayed their contribution to sustainability and food security. For instance, SSF have received much less financial, institutional, and scientific support than their large-scale counterpart and are underrepresented in policy discussions [12–14]. While data deficiencies are observed in all types of fisheries [3], the consequence of this pervasive shortage of reliable data is severe in the context of SSF due to their importance to environmental stewardship, local employment, food security, and poverty eradication.

The unique characteristics of SSF and the challenges faced when collecting SSF data require large-scale, innovative data collection methods and effective information systems. The Sea Around Us project<sup>1</sup> based at the University of British Columbia, Canada, is one such initiative. The project's database offers time series data of world fisheries catches based on reconstruction efforts that account for a variety of information sources. The interactive Web interface of the Sea Around Us project database allows users to decide at what spatial scale they are interested in seeing catch data. Prior to 2016, estimated catches were reported as an aggregation from all sectors. In its current version, total catches are differentiated into several dimensions, and estimates of SSF catches (categorized into artisanal and subsistence) are available for all coastal states [15]. While SSF catches have been previously estimated [16,17], this was the first SSF catch data time-series, showing data from 1950 to 2010 [18].

However, catch data alone are neither sufficient to describe the complexity of SSF nor appropriate to illustrate the values and importance of this sector. A new information system was needed to enable the capture of key parameters of SSF and undertake multi-level and multi-scale analyses of their contributions. The effective design and development of such a system should rely, for the most part, on

interactions between fishing communities, researchers, practitioners, national fisheries policymakers, and other related administrations. A large network, Too Big To Ignore (TBTI) - Global Partnership for Small-Scale Fisheries Research, was established to facilitate such collaborations, serving as a knowledge mobilization hub for SSF data and other information considered useful to promote the sustainability of SSF worldwide. As a research network, with the majority of members belonging to academic institutions, TBTI supports the generation of knowledge and aims at making connections with policymakers and other relevant partners.

TBTI is a multi-year project that began in 2012, initially comprising 65 members and 15 partner organizations from 25 countries. As an open network, it has grown to more than 400 members and expanded its coverage to 45 countries. With goals of elevating the profile of SSF and addressing their marginalization, one of the main activities of TBTI is to develop a novel information system that can help improve understanding of SSF and the roles that they play in society. TBTI's Information System on Small-scale Fisheries (ISSF) aims to capture the key characteristics of SSF around the world in any given location and across the 'fish chain' - from aquatic ecosystem to plate [19]. Given that ISSF is the first global information system on SSF, much can be learned about the design principles and data collection approaches informing the database, as well as the analysis, design, and development process that led to its creation. Equally important is the discussion about the data already collected by ISSF and what it reveals about SSF worldwide.

The following section presents the architecture and functionalities of ISSF. Next, the different datasets are described, along with analyses of the data collected to date and a presentation of the knowledge gained through the use of ISSF. The final section discusses the advantages and disadvantages of the key design of ISSF and highlights next steps.

## 2. ISSF architecture and functionalities

ISSF is an online, interactive, open data system that provides information about various aspects of SSF anywhere in the world. Through crowdsourcing, it aims to support the global SSF community by allowing anyone with an Internet connection to contribute information and access aggregated data through coordinated map and table views [20]. Users can interact with the system by simple browsing, conducting advanced searches, exploring detailed information, and obtaining reports, as well as downloading data for further use. The vision for ISSF is that it will become a one-stop Web portal with functions and features that foster collaboration and knowledge exchange among SSF stakeholders, as well as serve as a collective archive of information on SSF (Fig. 1).

The system design and initial development took place from September 2012 to September 2014, when the first public version of ISSF was officially released in Merida, Mexico, during the 2nd World Small-Scale Fisheries Congress. During the development phase, several tests were conducted with end users to gauge its ease of use, interface friendliness, word choice, and aesthetic appeal. Further development of ISSF took place until December 2015, adding a number of functionalities including additional datasets, the ability to export data and generate reports, and advanced mapping capabilities that can display country statistics using thematic maps.

The development of ISSF involved many considerations, both in terms of technical aspects and content. Different technology options were explored and the decision was made to develop ISSF using open-source technologies for greater flexibility. ISSF data are stored in the PostgreSQL relational database management system, which allows associating information from different datasets within the system. The PostGIS extension was incorporated to facilitate spatial queries. ISSF uses the Django web development framework, developed and customized using the Python programming language. User interactivity capabilities are based on the Foundation JavaScript (JS) library and the mapping functionalities were developed using the Leaflet JS library.

<sup>1</sup> [www.seaaroundus.org](http://www.seaaroundus.org).

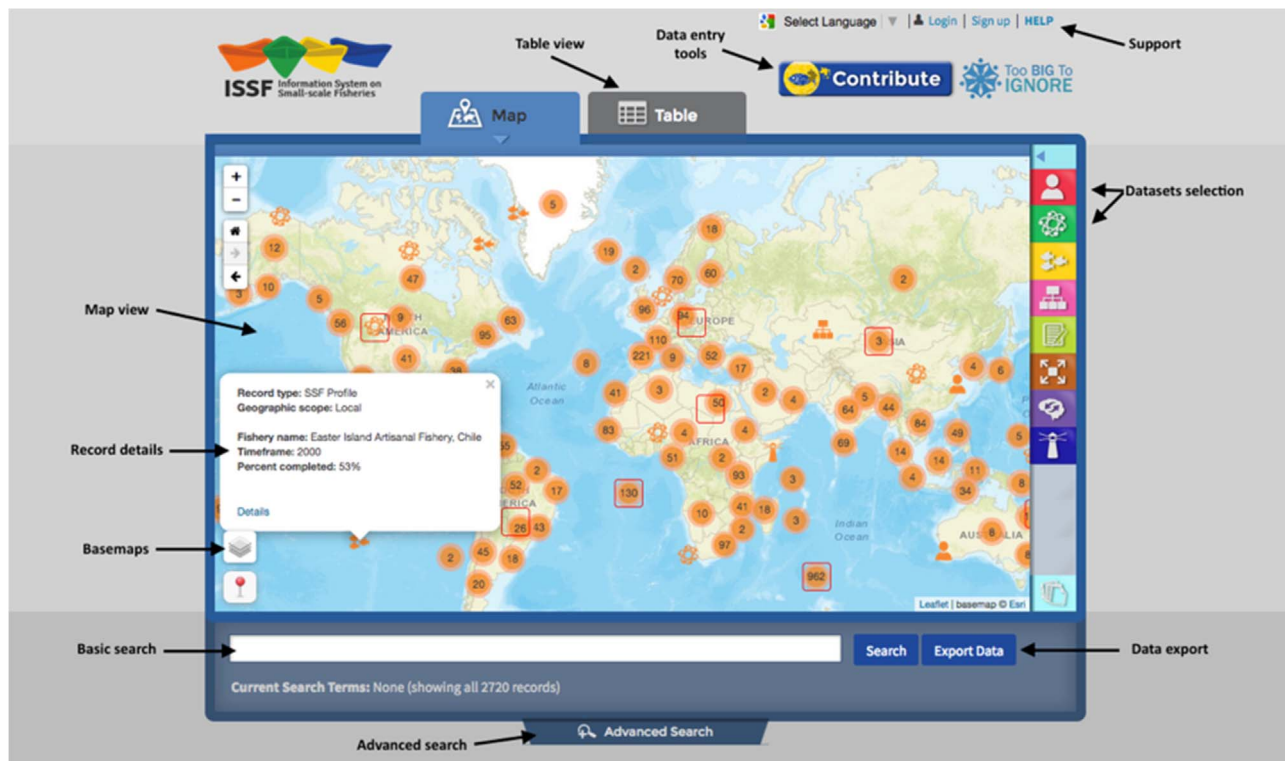


Fig. 1. The Information System on Small-scale Fisheries (ISSF) main interface and some of its key components.

ISSF runs on the Linux operating system with Apache web server software and is hosted at Memorial University of Newfoundland, Canada. The tool is available at <http://issf.toobigtoignore.net/>.

ISSF's main interface (see Fig. 1) was designed to be as simple as possible, allowing users to drill down from an aggregated view of the information, to details about each individual record, and then to traverse laterally to related records. ISSF offers the choice between navigating using a map view or a table view. The map uses basic navigation tools (i.e. zoom in, zoom out, and pan), allowing the user to view individual datasets as data layers on the map, and offers various basemaps as a background, including FAO fishing areas, large marine ecosystems, and exclusive economic zones. Basic search tools allow searching for records from any dataset that include specific keywords (e.g. "capacity India"), with results sorted by relevance. The search function takes advantage of the PostgreSQL's novel table inheritance functionality to search across multiple datasets without having to search the table for each dataset. Advanced search tools offer more control, allowing for search by contributors, countries, years, themes/issues (e.g. "gender"), and/or SSF characteristics (e.g. "gear type", "governance mode"). The data retrieved by any search can be exported as a CSV file for further analysis. The main ISSF page includes information about the most recent data entries, a Twitter feed, a short introductory video to ISSF, and a "Who's Who" column highlighting active ISSF users. Every ISSF page supports basic Google multilingual translation and comments/discussion via Facebook. Beyond the data exploration tools, ISSF allows visitors to create a free account that permits them to contribute data and associates that data with the contributor. The Help section provides guidance on creating an account and contributing or editing data and offers a series of short videos that provide basic training on the system. Recognizing that there will likely be a language barrier for many international users, a 'Google Translator Plugin' is embedded on the main ISSF page, allowing for an automated translation of the interface into 90 languages.

Apart from the system architecture, the most important development decisions of ISSF were which datasets and attributes to include. Balancing between the 'need-to-know' and the 'nice-to-know' was a

delicate task, which could not be done by only a handful of experts. Thus, the content of ISSF was informed by a number of international workshops that involved large groups of SSF experts, such as fishers, practitioners, and researchers, as well as members of community groups, environmental organizations, and intergovernmental agencies. Workshops took place between 2012 and 2014 and were complemented by additional consultations with key international experts using videoconferencing, emails, and online surveys. The decisions about what data to include in ISSF were also related to the five main policy questions identified at the inception of TBTI through a consultative process. These include: (1) economic viability and vulnerability of SSF to global change; (2) SSF values, livelihoods, and wellbeing; (3) ecological impacts of SSF and their contribution to conservation and stewardship; (4) rights and access of SSF to resources and the decision-making process; and (5) institutions and principles suitable for SSF governance.

### 3. Current knowledge about SSF

In its current form, ISSF contains eight datasets (or 'layers'), each aiming to capture key aspects of SSF that are considered relevant to SSF stakeholders and policymakers. These layers include: (1) a 'Who's who in SSF' layer, which documents demographic information about SSF researchers; 2) an 'Organizations' layer, focusing on those working on SSF issues and the interests of small-scale fishing people; 3) a 'State-of-the-Art in SSF research' layer that summarizes key aspects of studies on SSF based on published papers and available reports and documents; 4) 'SSF profile,' a complex layer aiming to describe the entire SSF chain from ecological, economic, socio-cultural, and governance dimensions; 5) 'Case studies', a loosely structured layer enabling entries of textual information related to issues and challenges facing SSF; 6) a 'Capacity development' layer allowing users to indicate existing capacity and identify capacity needs in each SSF location; 7) an 'Experiences' layer, that targets fishers and community groups by encouraging them to tell stories that matter to them using text, photos, and videos; and 8) 'SSF Guidelines', a layer designed to monitor activities related to the Guidelines and their implementation. As of November 2016, ISSF



**Table 1**  
Contributors to ISSF by region.

Region	No. of contributors	No. of countries
Africa	23	11
Asia and Oceania	64	16
Europe	128	17
Latin America	101	17
North America	152	2
<b>TOTAL</b>	<b>468</b>	<b>63</b>

contains data from 468 contributors in 63 countries (Table 1). Although about 60% of the contributors are from North America and Europe, the majority of them work in developing country contexts.

As shown in Table 2, the overwhelming majority of the contributions are for the ‘State-of-the-Art’ data layer (68% of about 2600 records), followed by ‘Who’s Who’ (17%). Those two datasets were also the first two to be released, thus benefitting from over two years of crowdsourced contributions. The high number of organizations in Europe does not imply that there are more SSF-related organizations operating in that region. Rather, it reflects the concentration of TBTI efforts at acquiring that information in order to contribute to the discussion about the EU Common Fisheries Policy in 2013 [21]. With the SSF Profile being one of the most complex datasets in ISSF, it is not surprising that the number of records is low. As with other self-reporting systems, crowdsourced information leaves little control to site administrators about what data contributors submit to ISSF. Consequently, it is not possible to assume even distribution or representation of these datasets. However, despite the unevenness in coverage, the data contained in ISSF are informative, offering insights about SSF both in their own context and when compared to others elsewhere in the world.

Five regions are considered in the analysis: Africa, Asia and Oceania, Europe, Latin America (Mexico, Central and South America, and the Caribbean), and North America (US and Canada). The following syntheses illustrate the utility of ISSF in making SSF visible and improving knowledge about the sector. The next section begins with what ISSF has revealed about SSF, based on the ‘State-of-the-Art’ dataset that captures details about research in SSF. Next, portraits of SSF in various regions are presented using information available in the ‘SSF Profile’ dataset. Finally, the other datasets are summarized to highlight recent developments and discuss future opportunities for ISSF.

### 3.1. Locations and distribution of SSF research

While large online bibliographical databases such as ‘Scopus’, ‘ISI Web of Knowledge’, or ‘Google Scholar’ are generally used to search for literature, the open access information they provide is often limited to authors, title and abstract, year, and journal. Extracting further information, such as the studies’ goals, location, or the main issues addressed in the study, is only possible through an extensive literature review and requires access to scholarly databases. The ISSF ‘State-of-the-Art’ dataset aims to enable a more accessible summarization of the existing, but scattered, detailed information on SSF research [22]. All types of publications are included, from peer-reviewed papers to grey literature, as well as books, thesis, and documentaries. The ‘State-of-

the-Art’ dataset currently consists of 1774 studies related to SSF in 112 countries. A substantial proportion of these studies focused on SSF in North and South America, Europe, Southeast Asia, and coastal Sub-Saharan Africa (Fig. 2). However, information is lacking in the rest of Asia and Oceania, the Caribbean, and in landlocked countries of South America and Africa. The geographical distribution of SSF studies aligns well with the amount of researchers in the study locations. While researchers from developing countries tend to study SSF in their own locations, a closer look at the publications reveals that authors from developed countries often conduct research elsewhere in the world, often in developing countries.

### 3.2. What ISSF reveals about SSF research

Many types of SSF information can be highlighted through the analysis of the ‘State-of-the-Art’ layer. For example, it reveals differences in the types of fisheries on which research has focused. In Africa and Asia and Oceania, most publications deal with commercial and subsistence fishing (e.g. for family consumption), while in the rest of the world, commercial fishing research typically dominates. Interestingly, recreational fishing and aquaculture, despite being common activities around the world, are not widely studied in the context of SSF. Finally, indigenous fisheries were studied mainly in the US and Canada, constituting about 13% of publication records, which partially explains the high concentration of publication records in North America (Fig. 2).

#### 3.2.1. Fishing gears

A known characteristic of SSF is that they involve a wide variety of gears to target their catch. Nets (cast nets, gillnets, lift nets, and seines) are the most commonly reported gears in ISSF. In Asia and Oceania, many studies note the common use of hooks and harpoons, while in Europe and North America, research on SSF is often related to trawls and dredges. The use of traps seems to be common in all regions, while gleaning is more often documented in Latin America, as well as in Asia and Oceania. Finally, research shows that cyanide is still used in Asia and Oceania.

#### 3.2.2. Management measures

Since fisheries resources are limited, management measures are often implemented around the globe to help maintain both the viability of fishing activities and the health of fish stocks. According to ISSF records, studies about SSF in Africa, Europe, and North America document catch limit, or total allowable catch, as one of the main regulations employed in these regions. Individual Transferable Quotas (ITQs) are commonly referred to in North America (about 26% of the reported studies), while they are rarely discussed in other regions. Marine protected areas (MPAs), used both as conservation and fisheries management tools [23,24], gain research attention in the SSF contexts of Asia and Oceania and Europe (31% and 23% of the references, respectively). Also common in the management of SSF is community-based fisheries management, particularly in Asia and Oceania and Latin America (25% and 29% of the references, respectively). Licensing systems are often reported to be implemented, mainly in Africa (30% of the records), while a minority of published studies report the use of

**Table 2**  
Contributions in ISSF by dataset (\*includes also 565 records at global scale or for which the geographic coverage is not specified).

ISSF layer	Africa	Asia/Oc.	Europe	Latin Am.	North Am.	TOTAL
State-of-the-Art	295	206	224	289	195	*1774
Profiles	23	40	26	44	14	147
Who’s who	24	57	126	94	138	439
Organizations	11	17	191	23	21	263
<b>TOTAL</b>	<b>353</b>	<b>320</b>	<b>567</b>	<b>450</b>	<b>368</b>	<b>2623</b>

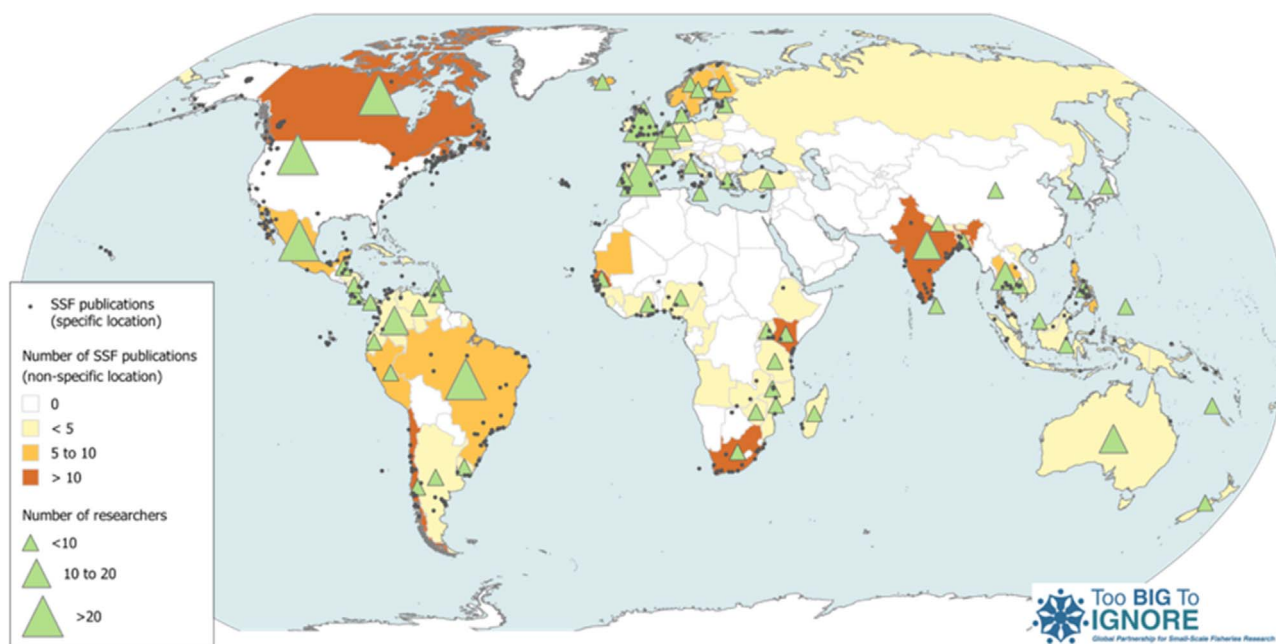


Fig. 2. Combined data from ISSF ‘Who’s Who’ and ‘State-of-the-Art’ layers, indicating areas where SSF research is active.

other input control measures, such as gear and vessel restrictions, to help manage SSF (about 3–12% of the records).

### 3.2.3. Governance modes

According to Jentoft and Chuenpagdee [25], many countries are undergoing governance transition, with a general tendency to gravitate towards co-governance. The ISSF publication records reveal a similar trend, with co-governance being the predominant governance mode reported in African countries, while in Asia and Oceania, both co-governance and top-down, state-controlled modes of governance are found (in 49% and 51% of the case studies, respectively). However, in other regions, top-down governance seems to dominate, as found in 62%, 69% and 70% of the case studies in Latin America, Europe, and North America, respectively.

### 3.2.4. Main issues

As shown in Fig. 3, governance and socio-cultural dimensions of fisheries dominate research in all regions, except in Latin America where ecological aspects receive greater attention. Further analysis shows that within the main issues, research topics vary by regions

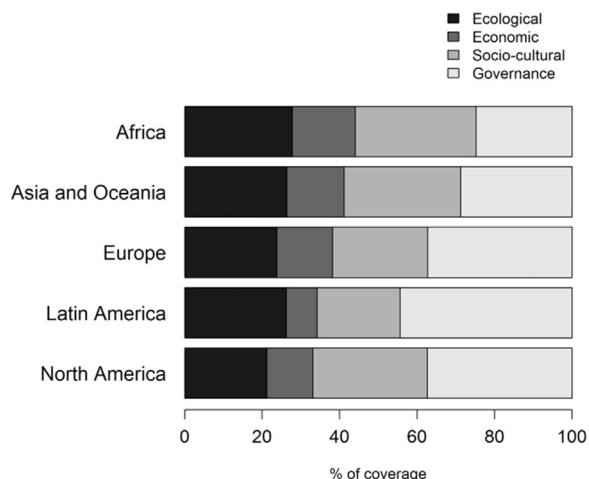


Fig. 3. SSF research dimensions covered in each region, based on the State-of-the-Art dataset.

(Fig. 4). Examples of common ecological issues are the biology and population characteristics of the targeted species and anthropogenic impacts on SSF. Other key topics include sustainable fishing and best practices, commonly described in studies located in Asia and Oceania, and MPA effectiveness, which is prominently considered in Europe. Research on governance in all five regions is concentrated around fishers’ participation in decision-making, which is one of the key elements in the SSF Guidelines [4]. With human rights as the underlying principle, the SSF Guidelines encourage FAO member states to establish mechanisms and processes to enable the active, meaningful, and informed participation of small-scale fishers in management and decision-making processes. Topics that are severely under-studied include those related to ‘meta-order’ elements of governance (e.g. values, principles, and goals) [26], as well as issues related to ownership and rights (including human rights), and politics and power. On the socio-cultural dimension, research on livelihoods takes place in all regions, with wellbeing, poverty, and vulnerability as other popular topics. Less attention has been given to gender and other complex social issues such as intergenerational knowledge, intersectoral relations, and power and conflicts. Finally, with respect to economic research, several topics receive strong research focus in all regions, such as economic and financial analysis, incentives and subsidies, and value-addition. Other ‘non-fisheries’ issues affecting the livelihoods of SSF are captured in various ways, including ‘anthropogenic impacts and threats’ in the ecological dimension, and ‘development, social change and adaptation’ in the socio-cultural dimension.

### 3.3. Profiling SSF around the world

The ‘SSF Profile’ dataset provides descriptions of SSF for a given place (e.g. a community or a country). SSF profile descriptions were standardized using ‘Top 20 attributes’ that guide contributors on key SSF characteristics. Those characteristics describe ecological, socio-cultural, economic, and governance dimensions (Fig. 5). Using a constant set of attributes to describe each profile was considered to be important to allow comparisons of profiles across space and time. Due to the complexity of SSF, the decision about what to include in these ‘Top 20 attributes’ and their associated features involved two years of intensive consultations with SSF experts, validated by SSF stakeholders. The discussion was informed largely by interactive governance theory



Fig. 4. Research topics addressed within each of the four main issues, by region. (Dark grey: topics representing more than 25% of all the addressed topics in the corresponding issue; Medium grey: representing 5–25%; Light grey: representing less than 5%; White: not addressed).

[19], particularly by the ‘fish chain’ concept. They also correspond to the big five questions underlying the TBTI project. The attributes have been selected also to counterbalance the tendency to focus on aspects of fisheries that are more commonly captured in other data collection efforts and/or easily quantified (e.g. catch by volume and value, number of fishers). Certain issues are made explicit in the framework to emphasize the current knowledge gap. Examples are SSF market channels, including the portion of fish retained for household consumption, the role of women in harvest and post-harvest activities, and the status of small-scale fishers in the community, inferred from how they are regarded by others and whether fishing is an occupation of last resort.

While the conceptual model (Fig. 5) treats each attribute individually, several of these dimensions are interconnected features of a fishery that together can help to draw a full portrait of SSF. The ‘Top 20 attributes’ serve as a novel template for describing SSF in a single location, with flexible options for geographic scale and timeframe. They also allow comparisons of fisheries, in addition to facilitating the aggregation of data at higher geographic levels in some cases. As of November 2016, 147 SSF profiles had been created in 57 countries, covering all five regions. However, Latin America and Asia and Oceania were in the lead, at 30% and 27% of the total profiles, respectively. The region with the smallest number of profiles was North America (10%).

The SSF Profile asks contributors first to provide information about

the term used to refer to SSF and whether there is any official definition of SSF in their context. Next, the basic characteristics of the particular fishery are described, including the type(s) of fishery (e.g. subsistence, commercial, recreational, aquaculture), location, and the geographic scope at which the fishery takes place. The ecological attributes comprise the ecosystem type(s) in which the fishery occurs, the types of gears and vessels used, and the target species and their associated landings. Detailed information about fishing effort, such as mean vessel length, engine size, crew size, and the number of days fishing per year are optional to enter if data are available. The number and percentage of fishers (by gender) illustrate the social characteristics of fishing communities and their representation in the considered area. These are valuable information, which until now have not been systematically collected. The next set of social attributes include the number of years that the fishery has existed in the location, how small-scale fishing people are regarded in society, and whether fishing is considered an occupation of last resort. These questions aim to capture the historical importance of SSF in each region and the social status of small-scale fishers.

To gain knowledge about the economic viability and market opportunities of SSF, information about household income from SSF, post-harvest activities (including the involvement of women), the percent of GDP contributed by SSF, what fishing households do in terms of other non-fisheries livelihood activities, and marketing systems are required.

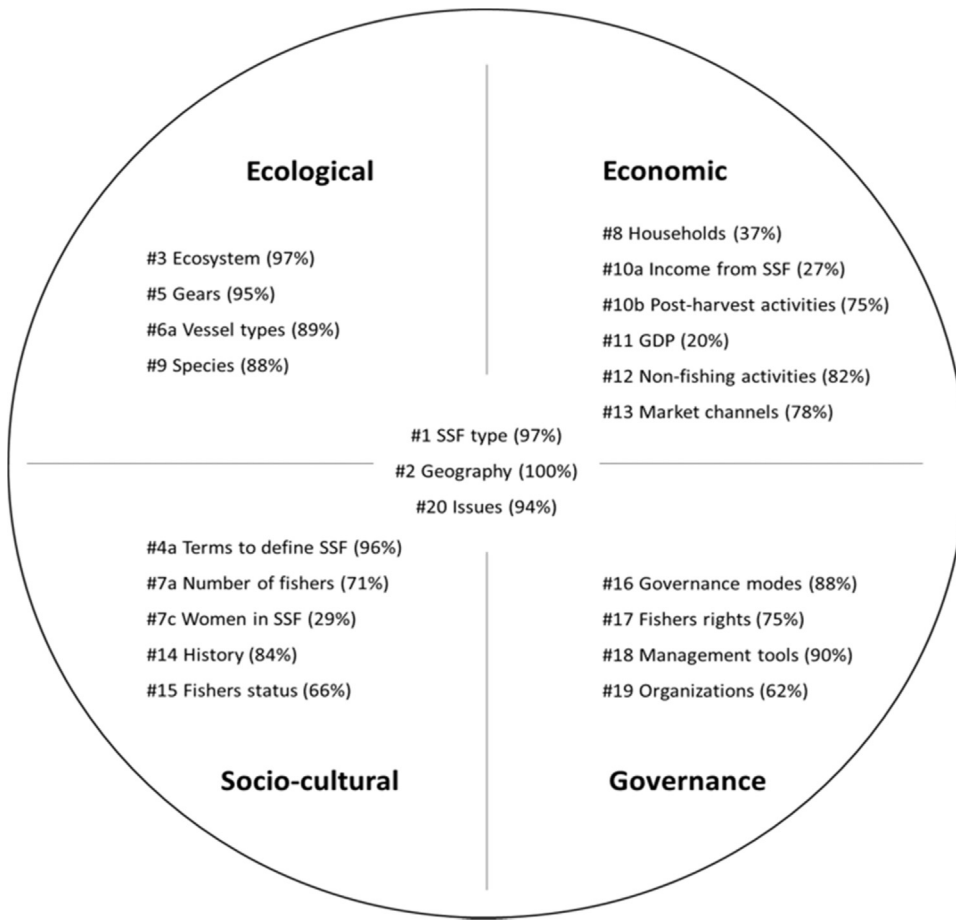


Fig. 5. A conceptual model for the “Top 20 attributes” of the SSF Profile dataset. The actual question number in the ISSF data template is shown, along with the percentage of completion for each attribute.

The latter includes aspects related to the portion of fish that is kept for household consumption instead of traded in local, domestic, or export markets. Four attributes aim to understand how SSF are governed, in accordance with interactive governance theory [19]. These include the governance mode (i.e. top-down, co-governance, self-governance, or community-based), and management measures and tools, as well as rules and regulations deployed in the considered location. Further, queries about property rights and access to resources help explain whether and how the rights of fishing people are considered in fisheries policy, while information about organizations helps identify other stakeholders who may be drawn in to support the sustainability of SSF, as promoted in the SSF Guidelines [4].

The final attribute in the SSF Profile dataset is related to concerns and challenges that SSF are facing in the location. This question is based on an understanding that SSF around the world are subjected to many issues that can make them vulnerable or may threaten their viability. Among these challenges are environmental degradation, such as destructive fishing practices, pollution and coastal erosion, and governance issues such as social injustice, ocean grabbing, and stakeholder conflicts.

### 3.4. Other datasets in ISSF

In addition to the ‘State-of-the-Art’ and ‘SSF Profile’ datasets, ISSF includes a dataset about organizations whose work is related to SSF. The ‘Organization’ dataset focuses on the goals, missions, networks, issues, and the main activities that they are involved in [27]. As of November 2016, ISSF includes information on 263 organizations from 45 countries. Another important dataset is related to the ‘SSF Guidelines’ layer. As suggested by Jentoft [28], adopting the SSF Guidelines alone is not sufficient; they need to be implemented as widely as

possible. The ‘SSF Guidelines’ dataset in ISSF was developed to help keep track of the different activities and discussions concerning the implementation of the SSF Guidelines since their adoption. As of November 2016, there have been 61 entries describing workshops, regional programs, and national plans, along with other discussion forum (Fig. 6). A high percentage of these activities took place at the regional level (particularly in Asia and Oceania), and also at the national level.

Finally, ISSF has three new datasets that are waiting to be populated: ‘SSF case studies,’ ‘Capacity development,’ and ‘SSF experiences’. These datasets are less structured and can accommodate longer texts, photos, and video. This particular design is intended to facilitate the

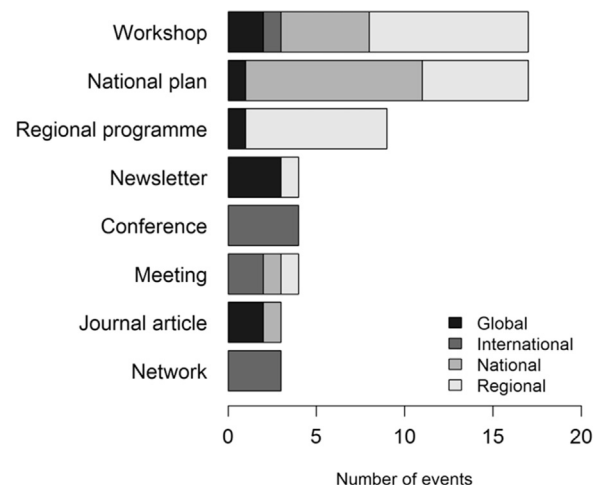


Fig. 6. Number of events related to the SSF Guidelines captured in ISSF, by type of event and geographic scale of activities.



flow of communication and information and to encourage community groups and individuals to contribute any form of knowledge and data on SSF worldwide that they consider as being relevant.

#### 4. Discussion and Conclusion

One of the major challenges in SSF governance is the lack of integrated knowledge about the sector. As previously mentioned, the reasons for such deficiencies are not only due to their sheer number, but also to the fact that they occur in all possible aquatic environments (e.g. marine, rivers, inland), in both rural and urban settings, and also involve men, women, and sometimes children in various pre-harvest, harvest and post-harvest activities. While some of these features can also be found in large-scale fisheries, standardized reporting systems exist to collect data about industrial fisheries and thus bias the official statistics that member states regularly supply to FAO. In effect, this reporting template is not designed to capture the diverse and complex features associated with SSF. Coupled with the lack of financial, human resource, and technical capacities, there has been little coordinated effort at either the regional or global scale to collect data about SSF explicitly, systematically, and routinely. More is now happening at the national and subnational levels to collect data about SSF, but these efforts are still far from sufficient to illustrate the contribution that SSF makes to food security, poverty alleviation, and local and regional economic development. The nature of research in SSF, which is often localized, fragmented, and not widely disseminated, is another impediment [11].

The development of ISSF was a major undertaking and a critical step in assembling information about SSF. It is the first extensive set of SSF data ever assembled, resulting from significant global consultations with a range of stakeholders. Unlike systems that are concretely conceptualized, ISSF was developed to allow for flexibility in terms of what the end products may look like. The web-based and open access nature of ISSF means that it has great potential to increase data accessibility. The key consideration in the design of ISSF concerns whether the most effective approach was taken to collect the data and whether the right data is being collected. The first question can be assessed based on the contribution statistics, while the second can be discussed in terms of the kind of questions about SSF that ISSF can help address.

##### 4.1. Pros and cons of crowdsourcing and web-based systems

While crowdsourced systems offer the potential to collect data not previously assembled, they present a number of challenges [29]. First, the quality of crowdsourced data (e.g. in platforms like Wikipedia or the mapping platform OpenStreetMap) is known to be inconsistent. Typically, this can be minimized by allowing a large number of people to modify the data, in order to ensure data quality, which is referred to as the Linus Law [30]. While this practice proved effective for large crowdsourcing platforms like Wikipedia, the number of experts in the fisheries of a given place can be small, necessitating a different mechanism to improve data accuracy. In ISSF, this was done by several means, including: (1) having a peer-review process in which experts in SSF can modify or even remove data that are thought to be inaccurate; and (2) allowing any ISSF user to leave a comment on any data record, possibly sharing insights or concerns about the quality of the data. Presently, these mechanisms are underutilized, and more efforts are required to encourage experts and users to engage in the data validation process.

A second challenge with crowdsourced systems is related to data availability. The success of the system relies on the ability to attract enough participation to gather sufficient data that ensures some consistency of records across geographies and times. Despite the use of the Google Translator Plugin and the provision of the SSF Profile 20 questions in English, French, Spanish and Portuguese, language restriction is acknowledged as creating a bias towards information

available in English. Increasing contributors' participations has been supported by a number of initiatives, including: (1) an initial seeding of core information by research assistants that summarized existing literature; (2) informing the TBTI community of the existence of the system through conferences, email lists, and social media; (3) providing new users with training material (e.g. frequently asked questions, introductory videos); and (4) organizing individual and national challenges for the most active contributors or groups of contributors. These efforts seem to lead to increased participation when they are launched, as observed in frequency of spikes showing increased website hits and contributions. However, it is difficult to sustain user engagement beyond these 'promotion' periods. Different types of incentives for diverse target groups will need to be provided to encourage their participation and contribution to making ISSF a rich and current resource.

ISSF is already structured to attract a wide range of stakeholders, starting from the research community, with the 'Who's Who' and 'State-of-the-Art' datasets. Some researchers may see ISSF as a way to promote their work, while others may prefer other platforms that do not require their active contribution, like Google Scholar or Research Gate. However, the choice is not only between being active contributors or users of information systems, but also relates to the relative appeal of general information systems or thematically specific ones such as ISSF. The focus on SSF is considered the strongest point of ISSF, since it is indeed the 'one-stop shop' for anything related to SSF. As interest in SSF around the world grows, especially since the adoption of the SSF Guidelines, the utility and value of ISSF will become more evident among users. For other stakeholder groups, like fishers, practitioners, and environmental groups, the challenge lies in the way in which ISSF interacts with them. The new layers, like 'SSF case studies' and 'SSF experiences', are designed to be flexible in terms of data type to attract new users. While data in these datasets are still limited, the current content suggests that non-academic audiences are more interested in these data layers, especially because they can contribute free form texts and long narratives and include photos and videos. A stronger and more direct engagement with fisheries administrators and decision-makers at the governmental level is required, however, to enhance the role that ISSF can play in improving SSF governance. This can be facilitated, for instance, by producing infographic materials based on ISSF data to communicate our findings with policymakers at different scales.

One final consideration about the design choice is related to the need for an Internet connection to access ISSF. Although Internet is widely available, nearly 75% of all users in the world (about 2.8 billion in 2014) live in 20 countries with the highest numbers of users, and within these countries, the degree of penetration varies greatly - from India, with only 19% of the population having an Internet connection, to the US, Germany, France, and the UK, with over 80%.<sup>2</sup> Thus, the majority of small-scale fishing people may not be able to access ISSF. The interactive features of ISSF, including the map interface, also require a relatively fast Internet connection, which may be another impediment. Several options have been discussed to overcome these challenges, such as developing ISSF into a mobile application. Ultimately, the amount and quality of information in a crowdsourced system like ISSF is subjected to the availability of the information, the willingness of the contributors to interact with the system, and ease of access, all of which need to be considered in the future phases of TBTI.

##### 4.2. Answering big questions about SSF

If ISSF already succeeded in creating the largest online knowledge base on small-scale fisheries, the ultimate test will be the uptake of the system by the end users and its ability to help answer important questions about SSF. It is too early to properly evaluate the performance of ISSF, especially in gauging the level of use of the information either

<sup>2</sup> Internet Live Stats ([www.InternetLiveStats.com](http://www.InternetLiveStats.com)).

in research, policymaking, or advocacy at local, national, and international levels. An early indication that ISSF may be gaining some traction is the acknowledgement of TBTI and its work in the 2014 State of the World Fisheries and Aquaculture report [31]. A set of criteria could be developed in the future to measure and assess the usability of ISSF, which could include indicators such as the number of references and acknowledgements in policy documents or the number of citations in research papers. Another way to evaluate the performance of ISSF is to analyze the results of ISSF and compare them with those from alternative sources. Such analysis could be performed when more data are available in ISSF.

The relevance of ISSF in answering key SSF questions is reflected in the consultative process taken to develop ISSF, and particularly in the decision to collect information about the ‘Top 20 attributes’ for the SSF profiles. While agreement was hard to reach about the socio-cultural attributes, due to the difficulty that experts had in reducing this complex aspect of SSF to only a few variables, they settled on the key ones, such as the historical dimensions of the fishery in the area, the recognition of fishers by the other members of society, and whether fishing is considered an occupation of last resort. These attributes help illuminate the socio-cultural values of SSF, which are difficult to elicit. They also align well with the key principles underlying the SSF Guidelines, which urge member states to follow principles such as human-rights and dignity, respect of cultures, and equity and equality in SSF governance [4]. As more information of this type is revealed, the SSF sector will become more visible and thus less marginalized in fisheries decision-making. This will then help support the transition in SSF governance, which is already being observed in several countries around the world [25]. According to these authors, community involvement is necessary for such a transition. Knowledge gained through ISSF can help empower communities, not so much because they can learn about SSF in their own location, but because they can become aware of SSF elsewhere in the world. The role of ISSF as a knowledge-sharing platform has great potential to change how SSF are governed. This cannot be done, however, without engaging directly with fisheries administrators and decision-makers who are key governing actors in SSF governance. ISSF can help bridge the existing gap between small-scale fishers and community groups on one hand, and policymakers on the other, as it brings all players to the same level of knowledge.

There are currently too few SSF profiles to produce an informative synopsis about SSF at a global scale. However, the preliminary analyses presented here suggest that many important aspects about SSF, in single locations and in comparison to others, have been revealed that provide rare insights about SSF. The questions about what SSF in different regions look like, how they differ from place to place, how they are governed, and what challenges and issues they are facing can be easily answered with the current data. The big five questions raised in TBTI are about issues affecting sustainability of SSF and are related to aspects of SSF that are not often gathered systematically in research design and practice. Engagement with the research community, practitioners, and policymakers to discuss the importance of these topics in improving SSF governance and for sustainability of SSF will be a necessary next step.

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