



Feeding the poor: Contribution of West African fisheries to employment and food security



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ABSTRACT

West African small-scale fisheries are analyzed to determine their contribution to the economy, food security (catches and employment) and poverty alleviation (income and choice of activity). Previous quantitative analysis revealed major discrepancies between official data (which essentially underreports artisanal and ignores subsistence fisheries catches) and re-estimated data obtained from various reports. This resulted in a doubling of the landed value of small-scale fisheries catches to 3.5 billion USD year⁻¹ compared to officially reported numbers. Similarly, employment estimated officially at 1 million fishers was found here to be only 70% higher when subsistence fisheries are included. For the 22 West African countries considered in this study, we estimate that 6.7 million people directly depend on fishing activities for their food and/or livelihood. Furthermore, the present study shows an increasing reliance of West Africa's coastal population on fisheries for their food and income despite decreasing total income and increasing fishing costs, which in turn aggravated poverty. The notion that small-scale fisheries could contribute to poverty alleviation despite crises and shocks is thus highly contestable. Indeed, although the number of people depending on fisheries is still increasing, driven by their current (even though decreasing) profitability, the perception of small-scale fishing as an activity of last resort is probably justified, and more appropriate than viewing it as a source of sustainable livelihood.

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1. Introduction

According to the FAO, all West African fishing grounds are fully or over-exploited (FAO, 2006). Declining stocks, and therefore catches, increase negative impacts on the coastal populations of West Africa. Malnutrition prevalence¹ in the region reaches over 30% of the population, which is often a result of poverty. In many instances the latter, and thus food security, can be related to declining fisheries caused in part by over-exploitation (Béné, 2003, 2004; Srinivasan et al., 2010). The depletion of marine resources has in turn severe effects on employment opportunities and standards of living of small-scale fishing households, with very limited alternative livelihood opportunities. Through unmonitored fishing agreements, illegal fishing, unsustainable discarding and

unmonitored fishing effort (Srinivasan et al., 2010), “the true burden of catch losses falls upon the world's poorest, the subsistence and artisanal fishers who are losing access to an important source of cheap protein” (Millennium Ecosystem Assessment (MA), 2005). These conditions in turn accelerate environmental degradation (Hardin, 2007) as fishers' behavior adapts to declining catches by intensifying and expanding fishing effort. Béné (2003) reported that there was “almost a complete absence of references to fisheries case studies in the current literature on poverty” and how it relates to fisheries with its key fundamental dimensions, i.e., employment and thus food access.

West African small-scale fisheries are labor intensive, geographically scattered, mostly unlicensed and difficult to monitor, and thus the employment and the number of people dependent upon them are difficult to assess, which results in the under-estimation of costs and benefits of fisheries (Teh and Sumaila, 2013). This situation challenges the proper understanding of the implications of increasing effort (i.e., fishing costs) and over-exploitation on poverty. Although, many small-scale fishers are thought to earn less than 1 USD day⁻¹ (Béné et al., 2010), it is

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¹ Percentages extracted from the World Bank database weighted by the population of each country.

hoped this situation could change (Kawarazuka and Béné, 2010) and it is still thought that “small-scale fisheries can generate significant profits, prove resilient to shocks and crises, and make meaningful contributions to food security and poverty alleviation” (FAO, 2003), while 40 years ago, coastal fishing communities were sought to “live within the margins of subsistence and human dignity” (FAO, 1974). Many development projects prioritizing fishing effort expansion in West Africa since the 1950s often turned out to be unsuccessful (Kaczynski and Fluharty, 2002). Today, these projects focus mainly on “sustainable” development and increase in productivity, however, as they fail to emphasize the importance of proper monitoring and enforcement of basic regulations (e.g. Thiao, 2009), they also result in failure. Is the hypothesis that ‘small-scale fisheries can prove resilient to shocks while making meaningful contributions to food security and poverty’ under the current conditions in West Africa and did the poverty situation improve?

The literature generally diverges when presenting numbers reflecting the importance of West African fisheries for food security and their contribution to the economy. Official figures of fish consumption vary between 4.9 kg capita⁻¹ year⁻¹ in Liberia and 44.6 kg capita⁻¹ year⁻¹ in Gabon (Béné and Heck, 2005). Similarly, fish contribution to animal protein consumption can be as low as 23% in Liberia and as high as 63.2% in Ghana (Béné and Heck, 2005). While discrepancies exist, they fail to undermine the relatively important role that fish, particularly those caught by the small-scale sector, play in the West African diet across the region (Béné et al., 2007). Moreover, these estimates are often based on the apparent consumption, which is computed from reported catch as opposed to actual landings.² For example, household surveys show that fish consumption estimated from actual catches is between 30% (average for Gabon³ and the Republic of Congo⁴) and 500% higher (Guinea Bissau⁵ and Sao Tome and Principe⁶) than that based on official landing data.

Similarly, the contribution of West African fisheries to the economy is often taken as the landed value without further consideration for the value added by the down sectors (processing, marketing, etc.). This introduces a downward bias when estimating the contribution of fisheries throughout the economy (Dyck and Sumaila, 2010; Zeller et al., 2007). Belhabib et al. (2014a) for example found that the contribution of Guinean small-scale fisheries to the GDP was 6 times higher than official estimates (Faro et al., 2005). This often results in the neglect of subsistence fisheries, which can be boat-based or conducted from shore (e.g. beach seining or shellfish collecting by women). These often yield substantial catches that are hardly ever included in official statistics.

Small-scale fisheries can contribute to food security through a) a direct contribution to fish consumption (e.g., subsistence fisheries

catches), b) increased purchasing power (income and employment in the artisanal sector) and thus diversifying household diet by accessing important food staples. Note that both subsistence and artisanal fisheries employ women, the former as fishers or gleaners, and the latter in the processing of fish, with both generating food and income (Harper et al., 2013; Kawarazuka and Béné, 2010).

This paper explores the economic and food security implications of the expansion of artisanal and subsistence fisheries throughout the twenty-two countries of West Africa. A secondary objective is to examine whether small-scale fishers income over time has been below or above the poverty line in the countries studied.

2. Conceptual framework

2.1. Definition of poverty

According to UNDP (1997) Human Development Report, “poverty means that choices most basic to human development are denied – to lead a long, healthy, creative life and to enjoy a decent standard of living, freedom, dignity, self-respect and the respect of others”. This definition highlights mostly the freedom of choice and some aspects of deprivation. Research has shown that poverty is a multi-dimensional phenomenon, which can be measured in terms of income and expenditure levels but can also be perceived in terms of individuals' social interactions and state of mental well-being (Oduro and Aryee, 2003).

Poverty implies restricted access to education attainments, health, safe nutrition and access to food and water resulting in a shorter life span (Sarr, 2008). It should be noted that poverty can be difficult to define in operational terms, one attempt at operationalizing it is through the concept of a ‘poverty line’, which can be absolute, i.e., independent of a society's standard of living, or relative to it. One economic definition of the poverty line is “the critical level on the welfare scale at which access to basic needs become restricted”, which is dependent on individual/household income (Callan and Nolan, 1991; Hagenaaers and van Praag, 1985). The World Bank defines a poverty rate as “the percentage of the population living below the national poverty line”. Globally, the (absolute) poverty line is set at 1.25 USD⁻¹₂₀₀₅·day⁻¹ (www.worldbank.org); under this limit, people, e.g. 40–50% of the West African population, is considered poor.

2.2. Definition of food security

According to Pinstrup-Andersen (2009), the definition of food security as the fact that “enough food is available, whether at the global, national, community, or household level” is restrictive to the supply side and doesn't capture the important aspects of access to food, nutritional value and food preferences as required by the FAO definition (Maxwell, 1996; Pinstrup-Andersen, 2009). Thus, food security was defined at the 1996 World Food Summit as “a condition when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life” (FAO, 2005). Food security in a household means that all its members are able to access food (Pinstrup-Andersen, 2009), whether directly (e.g. subsistence fisheries) or indirectly through revenue generation.

Ultimately, food security can be measured by a) the amount and quality of food intake relative to an absolute health standard such as those set internationally by the World Health Organization (WHO); b) physical access to food such as direct fish supply from small-scale fisheries; and c) economic access to food through e.g. income generated by fisheries and the related processes (processing, landing, repairs etc.) and thus employment (FAO, 2005). The

² Total catches include sectors that are missing from official landing data. Often these include a large part of small-scale artisanal and subsistence fisheries given their scattered and non-commercial nature, by-catch and recreational fisheries.

³ Gabon: fish consumption rate was derived from the household survey by Wilkie et al. (2005) at 55 kg capita⁻¹ year⁻¹ and compared to an apparent consumption rate of 44.6 kg capita⁻¹ year⁻¹ (Béné and Heck, 2005).

⁴ Republic of the Congo: the consumption rate estimated at 35 kg capita⁻¹ year⁻¹ was derived from household surveys (Anon., 2006; Backiny-Yetna and Zodon, 2009) and compared to an apparent consumption rate of 25.3 kg capita⁻¹ year⁻¹ (Béné and Heck, 2005).

⁵ Guinea Bissau: A household survey estimated a consumption rate of 26 kg capita⁻¹ year⁻¹ (Dia and Bedingar, 2001) compared to an apparent consumption of 3 kg capita⁻¹ year⁻¹ (Sub-Regional Fisheries Commission, 2001).

⁶ Sao Tome and Principe: A fish consumption rate (57.8 kg capita⁻¹ year⁻¹) was obtained by averaging household survey fish consumption rates obtained for 2002 (53 kg capita⁻¹ year⁻¹), 2008 (89.9 kg capita⁻¹ year⁻¹) (Espírito Santo and Pacheco de Carvalho, 2010) and 2007 (30 kg capita⁻¹ year⁻¹) (Scopa et al., 2007) and compared to the apparent consumption of 21.4 kg capita⁻¹ year⁻¹ (Béné and Heck, 2005).

latter allow for a better and more diverse diet which in turn is strongly related to (a) and (b) above. Assessing food security and the contribution of, e.g., small-scale fisheries to food security, could be made through incomes (Pinstrup-Andersen, 2009) and thus employment, if the assumption can be made that a reasonable share of the household income is devoted to food, which is often the case in the developing world, e.g., West Africa (Huppé et al., 2013; Maman Bachir and Ould Hamadi Cherif, 2013; Smith et al., 2006). Indeed, devoting a large fraction of one's income to food is a common measure of poverty (Maxwell, 1988, 1996).

2.3. Definition of small-scale fisheries

There is no definition that can be applicable to all small-scale fisheries world-wide given their very dynamic nature (FAO, 2005). However, the boundaries between small-scale and large scale fisheries could be easily set using a broad range of characteristics that are common to small-scale fisheries. Teh and Sumaila (2013) characterized small-scale fisheries as aiming towards local consumption (subsistence or sold in local markets), requiring and generating low economic input and output, generally non-motorized, conducted close to shore and which are minimally managed if at all, with traditional beliefs. However this definition would exclude newly developed “small-scale” fishing techniques where fishers motorize their boats to reach further grounds (in some cases well beyond the inshore waters), and the landless farmer and cattle-less pastoralists that have recruited in the small-scale fishing sector in the last decades, notably in West Africa (Pauly, 2006). It further excludes small-scale fisheries aimed at export markets as included in the set of characteristics by an FAO working group (FAO and Advisory Committee on Fisheries Research, 2004) which now prevail in some countries, e.g., Senegal, and Mauritania. Therefore, we find it appropriate to broaden this set of characteristics to define small-scale fishers (especially artisanal fishers in West Africa), which should also include other characteristics:

- Catches are aimed at local consumption but also export markets;
- Fisheries are labor intensive;
- Fisheries require and generate low economic input and output with fuel costs constituting most of the economic input;
- Fisheries are increasingly motorized, but with lower access to technology;
- Fisheries are conducted generally close to shore;
- Fisheries are non-gender discriminative as women are also involved in this sector (Harper et al., 2013);
- Fisheries are multispecies but highly selective;
- Fisheries can be either part time or full time;
- Fisheries are usually minimally managed, herein including artisanal and subsistence fisheries.

3. Methods

We follow a four step-approach; first, we compile and summarize a re-estimated total small-scale catch (subsistence and artisanal) and compare it to total landings as reported officially through the FAO, in order to account for the under-reporting. FAO data do not distinguish between industrial and artisanal sectors, thus national data (obtained for short time periods between 1950 and 2010) which differentiates between artisanal and industrial sectors were used to disaggregate FAO data. Second, employment is assessed as the number of full time and part time fishers (and their dependents) employed by the small-scale sector, which represents the number of people supported by small-scale fisheries in West

Africa. Third, we provide an estimate of the landed value and profitability, with the landed value calculated as the product of the reconstructed small-scale catch (in contrast to reported landings) and the ex-vessel price from Sumaila et al. 2007; Swartz et al. (2013). Profitability, defined here as the ratio of the net income (i.e., total revenue minus total cost) to the total revenue per month, is used to assess the ability of West African small-scale fisheries to generate revenues as compared to their costs. A main outcome of this second step will be to account for the “salary” received by fishers and compare it to the poverty line. Finally, the economic impact of small-scale fisheries on African economies will be assessed in contrast to the landed value. This will account for the secondary activities related to fisheries, in particular the processing activity by women that can add up to 65% to the landed value (Roy et al., 2009).

3.1. Data collection

Small-scale catch data per country for the West African region (Fig. 1) encompassing the 21 countries from Morocco in the North to Namibia in the South were extracted from various catch reconstruction reports⁷ which estimated the unreported component of small-scale fisheries catches, i.e. the portion of the artisanal catch that is not reported and the subsistence catch relying on a wide range of references including (but not limited to) field surveys, published and unpublished literature, expert and industry observations and in-country workshops (Belhabib, 2015a, b, c; Belhabib and Divovich, 2014; Belhabib et al., 2014a, 2012a, 2012b, 2015a, 2015b, 2014b; Belhabib et al., 2013a; Belhabib and Pauly, 2015a, b, c; Belhabib et al., 2015c, 2013b, 2015d; Etim et al., 2015; Nunoo et al., 2014; Santos et al., 2012; Seto et al., 2015). Catch data are presented by sector (artisanal and subsistence) and cover the period between 1950 and 2010.

3.2. Employment estimate

Employment in small-scale fisheries of West Africa is defined as the number of full time and part time fishers employed by the small-scale sector, which encompass artisanal and subsistence [coastal lagoon and open sea] fishers [boat owners and crew]. The number of boat owners is taken as the number of boats, while the crew is estimated by multiplying the average number of the crew by the number of boats per segment of the fleet. Herein, we used the weighted average equivalent number of fishers for the total artisanal fleet (see online supporting materials). Finally, the number of lagoon and subsistence fishers was obtained from the above-cited catch reconstruction reports.

The number of people supported by West African fisheries (D_t) is obtained as the product of the number of fishers (F_t) and the number of dependents per fisher calculated as the average size per household (H_t) minus 1, to which is added the number of subsistence fishers (S_t). Thus $D_t = F_t(H_t - 1) + S_t$. H_t is obtained from various sources, and interpolated when needed to fill in the gaps (See online supporting materials). Herein, dependents of subsistence fishers were not included as in some instances the same household has a professional and a non-professional fishing member in it. While this may introduce a bias, it results in a more conservative estimate.

⁷ For Cameroon, data were extracted from the FAO FishStat database and then compared to national (recent) artisanal catch data estimates, which allowed filtering out industrial catches from the FAO dataset.

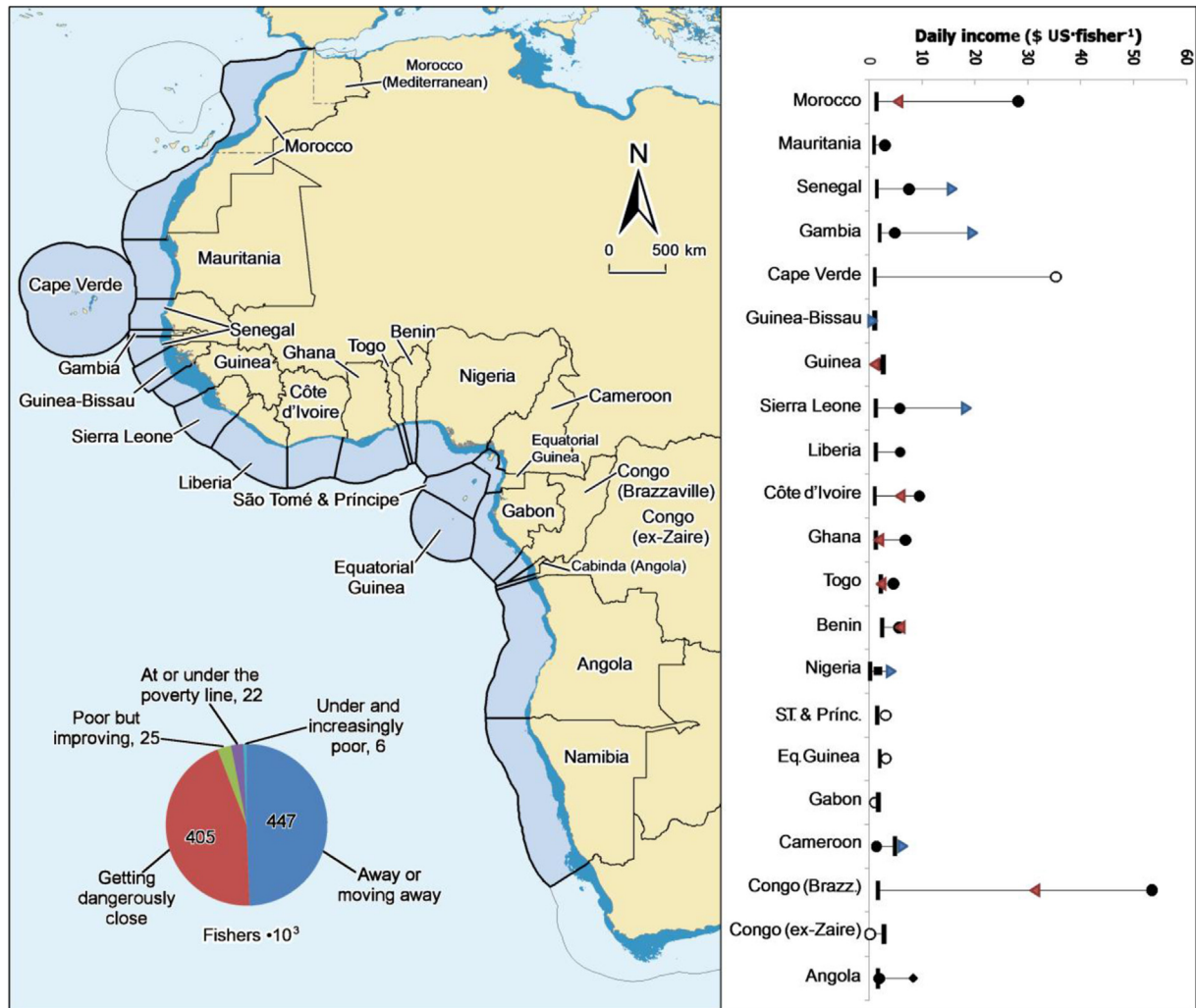


Fig. 1. Fisher's income in West Africa as compared to the national poverty line. Dark lines represent the national poverty line in each country; filled circles represent the 'past' situation, arrows represent the direction and value of the 'present' situation; and empty circles show the only data point available ('present') and how it compares to national poverty line.

3.3. Landed value and profitability

The annual landed value was obtained by multiplying the estimated small-scale catch (C_t) by the ex-vessel price (P_t), which is the value of the fish at landing, i.e., $V_t = C_t \times P_t$. Ex-vessel price data in USD₂₀₀₅ were extracted from the *Sea Around Us/Fisheries Economics Research Unit* price database (Sumaila et al., 2007; Swartz et al., 2013). We adjusted nominal ex-vessel prices to obtain 2013 ex-vessel prices using the Consumer Price Index (CPI) from the World Bank database (www.worldbank.org/ddp/home [2014]). We multiplied 2013 ex-vessel prices by (1) the artisanal reported landings to estimate the reported value for artisanal fisheries; (2) the estimated small-scale (subsistence and artisanal) catch to estimate the total reconstructed small-scale catch value.

Profitability is used to assess the ability of West African fisheries to generate revenue that is over and above the cost of fishing. It represents the ratio of the net income (NI) to the total revenue per month (R)⁸ i.e., $P=NI/R$, where $NI = R - (C_v + C_f)$, where C_v denotes variable (i.e., operating costs) and C_f stands for fixed costs.

⁸ The latest data available were for 2010, which we use herein as a baseline expressed in 2013 USD.

Profitability was estimated across all gears, as costs were averaged to allow for harmonization and extrapolation of costs.

Studies documenting the cost of artisanal fishing were available for West Africa and are summarized in Table 1, which allowed us to compare the "past" situation to "present". We adjusted costs onto current costs using CPI.

3.4. Economic impact of West African small-scale fisheries on the economy

Using the landed value as a proxy for the fishery's economic output ignores the downstream activities related to fisheries (Christensen et al., 2014; Pontecorvo et al., 1980), which in the case of labor intensive fisheries such as those in West Africa could greatly under-estimate the full economic impact of fisheries. For example, the processing activity by women that adds up to 65% to the landed value in Guinea would not be included (Belhabib et al., 2014a). However, as "indirect and induced multiplier effects of small-scale fishing activities are generally not disaggregated at national level and are often difficult to estimate" (FAO, 2005), the landed value is used to estimate the contribution of small-scale fisheries throughout the economy as percent of the GDP. To

Table 1
References used towards estimating the costs of fishing.

Country	Year	Reference used
Morocco	2001	(Malouli Idrissi et al., 2001)
Morocco	2009	(ArtFiMed, 2009)
Mauritania	1994	(Turay and Verstralen, 1997)
Mauritania	2002	(Oceanic Developpement, 2002)
Senegal	1974	(Everett, 1976)
Senegal	1994	(Horemans, 1996; Turay and Verstralen, 1997)
The Gambia	1994	(Turay and Verstralen, 1997)
The Gambia	1995	(Horemans et al., 1996)
The Gambia	2010	(Lam et al., 2011)
Cape Verde	2010	(Lam et al., 2011)
Guinea Bissau	1993	(Kébé et al., 1993)
Guinea Bissau	2010	(Lam et al., 2011)
Guinea	1990	(Diallo and Fautrel, 1999)
Guinea	1997	(Turay and Verstralen, 1997)
Guinea	2000	(African Development Bank, 2000)
Guinea	2010	(Belhabib et al., 2014a)
Sierra Leone	1974	(Everett, 1976)
Sierra Leone	2010	(Lam et al., 2011)
Liberia	2010	(Lam et al., 2011)
Côte d'Ivoire	1994	(Turay and Verstralen, 1997)
Côte d'Ivoire	2010	(Lam et al., 2011)
Ghana	1977	(Wayo Seini, 1977)
Ghana	1995	(Lery et al., 1999)
Ghana	2010	(Anderson et al., 2011; Mensah, 2012)
Togo	1994	(Denke, 1997)
Togo	2010	(Lam et al., 2011)
Benin	1994	(Turay and Verstralen, 1997)
Benin	2010	(Lam et al., 2011)
Nigeria	1974	(Everett, 1976)
Nigeria	2010	(Olaoye et al., 2012)
Cameroon	1994	(Turay and Verstralen, 1997)
Cameroon	2010	(Lam et al., 2011)
Equatorial Guinea	2010	(Lam et al., 2011)
Gabon	1994	(Kébé et al., 1996)
Gabon	2010	(Lam et al., 2011)
Sao Tome and Principe	1994	(Horemans et al., 1994)
Sao Tome and Principe	2010	(Lam et al., 2011)
Congo (Brazz.)	1986	(Gobert, 1986)
Congo (Brazz.)	2010	(Lam et al., 2011)
Congo (Ex-Zaire)	2010	(Lam et al., 2011)
Angola	1984	(Krantz, 1984)
Angola	2010	(Lam et al., 2011)
Namibia	2010	(Lam et al., 2011)

account for direct and indirect effects of the marine fishery on the economy, and allows for the estimation of the total output supported throughout the economy at a given fisheries landed value, a fishing output multiplier approach was developed by Dyck and Sumaila (2010). This multiplier accounts for the landed value weighted multiplier (M) and was estimated for West African countries (see Table 2), i.e., each dollar of the landed value generated by West African fisheries (V) can be expected to generate M dollars of downstream economic output (E), or $E = V \times M$.

4. Results

4.1. Small-scale fisheries catches from West Africa

Total small-scale catches in West Africa include artisanal (86%) and subsistence (14%) catches. Total small-scale catches increased from 599,000 t year⁻¹ in 1950 to a peak of 2.4 million t year⁻¹ in 2004 after which they plateaued at around 2.3 million t year⁻¹ in the late 2000s. Of this, only 1.4 million t year⁻¹ were reported officially, mainly through the partial inclusion of artisanal catches (Fig. 2).

4.2. Employment generated by West African small-scale fisheries and the dependent population

The number of active people within West African marine small-scale fisheries increased from 953,500 in the 1950s to over 1.7 million in 2010, of which over half (905,500) are employed by the artisanal sector alone (Table 2). Although the total active population within the small-scale fisheries extractive sector (i.e., excluding other activities) represents only 1% of the 2010 total labor force of West Africa, in poor countries such as Guinea Bissau, Guinea, Ghana and Gabon, it is as high as 20% of the labor force and a quarter of the coastal population (Table 2). The number of dependents presented in Table 2 was estimated at 5 million people, which together with a total employment of 1.7 million people for 2010, represented around 18% of the West African coastal population. This rate has been increasing since the early 2000s (coastal population 30 million for a total of 4.8 million people depending on marine small-scale fisheries, i.e. 16%).

4.3. Economic analysis of West African small-scale fisheries

4.3.1. Landed value

The economic analysis revealed that ex-vessel prices did not vary greatly during the 1950–1970 time period, oscillating between a minimum of 830 USD t⁻¹ and a maximum of 1200 USD t⁻¹ with however a great variability per country (up to 70%). Ex-vessel prices plateaued at around 2600 USD t⁻¹ between the early 1970s and the early 1980s, then decreased to 1500 USD t⁻¹ in 1991 due to the civil wars in Sierra Leone and Liberia, the political situation in Equatorial Guinea and overall highly variable inflation rates, which likely explained ex-vessel price variation noted later on. The landed value of total small-scale catches was estimated at 114 billion USD between 1950 and 2010, which is twice as high as the value of reported landings (52.9 billion USD). The total landed value was relatively constant in the past, at an average of 519 million USD between 1950 and 1960, compared to a value of reported landings of 86 million USD. The landed value of total small-scale catches increased to a first peak of 3.6 billion USD in 1982, before the declaration of most of EEZs of West African countries. The landed value of total small-scale fisheries was then 60% higher than the value of reported landings (Fig. 3). The landed value of total small-scale fisheries declined rapidly (due to the reasons mentioned above) to less than 1.5 billion USD in 1991 and varied later on to plateau at around 3.5 billion USD in the late 2000s compared to a landed value of reported catches of 1.7 billion USD (Fig. 3). Thus, this study reveals that the socio-economic contribution of small-scale fisheries in West Africa was under-evaluated.

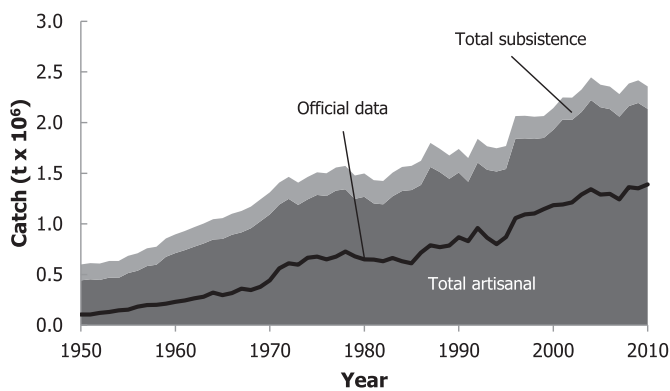
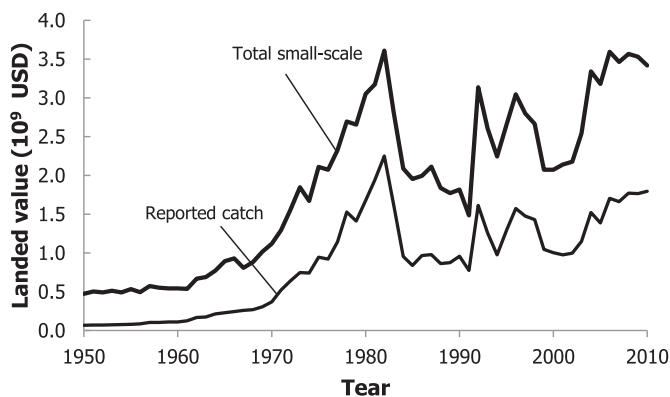
4.3.2. Profitability

Overall, the average net monthly income was estimated at 275 ± 91 USD fisher⁻¹ month⁻¹ for past time periods and decreased to 248 ± 62 USD fisher⁻¹ month⁻¹ which represents a slight decrease compared to a boat owner net income of 1753 ± 623 USD fisher⁻¹ month⁻¹ which increased to 2073 ± 1089 USD fisher⁻¹ month⁻¹ more recently. This disparity is mainly due to operating costs assumed by the crew and the boat owner being higher than depreciation (fixed) costs which given the relatively high age of fleets is negligible. Fuel costs for example represent around 40% ± 10% of total costs.⁹ This adds to a sharing system that

⁹ While slow increases in fuel prices may be compensated by increasing fuel subsidies to the fishing industry, resulting in little impact on fisher's profitability, spikes in oil prices were shown to severely affect the profitability of small-scale fisheries (Suuronen et al., 2012).

Table 2Employment (artisanal and subsistence fishers) generated by West African fisheries (10^3) between 1950 and 2010 and the number of artisanal fishers (2010).

Country	1950s	1960s	1970s	1980s	1990s	2000s	2010	Artisanal fishers (2010)	Dependents (2010)	Labor force (2010)	Coastal population (2010)
Morocco	7.2	6.8	6.3	8.3	20.5	54.9	75.7	75.6	294.8	11,371.6	7163.4
Mauritania	1.9	2.4	2.8	3.6	11.0	18.4	19.4	16.7	82.8	1150.0	478.5
Senegal	7.7	13.3	17.9	43.4	51.9	55.6	58.2	56.8	438.8	5569.6	4149.8
The Gambia	0.4	0.7	1.4	2.3	3.5	4.1	4.4	1.4	18.2	10,204.9	950.2
Cape Verde	0.8	1.3	1.5	3.1	3.3	3.2	3.4	3.4	13.2	8157.9	491.3
Guinea Bissau	100.6	122.0	143.3	161.1	178.6	207.9	226.4	5.9	255.2	673.8	681.6
Guinea	179.5	240.1	311.6	315.6	200.1	89.7	94.5	24.9	289.4	704.6	1319.8
Sierra Leone	13.1	15.0	17.8	21.5	17.5	30.4	35.2	35.2	172.5	2232.5	1440.4
Liberia	4.5	5.6	4.9	5.4	3.7	9.2	14.4	8.0	39.3	1372.3	993.5
Côte d'Ivoire	11.8	16.2	17.1	14.4	15.2	15.3	14.1	8.3	64.0	221.0	1963.5
Ghana	484.0	523.8	546.6	535.3	554.1	606.4	636.9	249.7	1573.2	4463.8	4157.6
Togo	4.9	7.0	8.8	6.5	6.0	6.3	6.6	5.0	26.6	2951.7	1214.6
Benin	15.1	31.8	46.0	49.9	61.7	71.9	74.2	64.2	263.6	3917.0	1618.2
Nigeria	12.8	23.8	34.8	58.2	118.3	152.0	168.0	168.0	621.6	49,706.6	3746.9
Cameroon	5.0	5.7	12.2	18.9	22.2	22.7	22.7	22.7	77.3	7442.3	1833.9
Equ. Guinea	4.4	5.2	4.6	4.7	12.6	9.8	12.2	6.1	29.3	365.8	241.5
Gabon	59.7	58.7	92.1	125.0	158.5	165.2	96.3	10.0	126.3	574.0	783.4
Sao T. & Princ.	1.3	1.6	1.9	2.2	2.2	2.4	2.8	2.8	12.6	62.4	160.7
Congo (Brazz.)	7.1	9.3	12.8	16.8	22.2	28.5	29.5	2.6	35.3	1677.1	723.5
Congo (ex-Z.)	15.4	16.4	16.9	17.4	18.2	17.6	10.8	3.2	21.5	24,385.9	44.6
Angola	16.3	20.3	23.6	37.0	75.1	110.0	135.0	135.0	540.0	7111.7	3612.5
Namibia	0.0	0.1	0.1	0.1	0.1	0.2	0.2	0.0	0.2	831.1	102.7
Total	953.5	1126.8	1325.1	1450.4	1556.4	1681.8	1740.9	905.6	4995.6	145,147.6	37,872.0

**Fig. 2.** Total small-scale catches from the waters of 22 West African countries as compared to officially reported data, 1950–2010.**Fig. 3.** Economic indicators for West African small-scale fisheries showing the real landed value of reported and total small-scale catches, 1950–2010.

provides the boat owner with over 52% of the revenues after operating costs are removed. Although boat owner income increased, profitability has decreased from $47\% \pm 8\%$ – $41\% \pm 9\%$ as

costs increased from 208 ± 187 USD boat⁻¹ month⁻¹ to 270 ± 178 USD boat⁻¹ month⁻¹. Although averages provide an overall overview of the profitability of West African small-scale fisheries, the significant discrepancies in the estimates per country are worth noting. Indeed, although the average fisher's daily income is well above the international poverty line (NPL) set at 1.25 USD day⁻¹, fisher's income in Guinea Bissau, Guinea, Ghana, Togo, Gabon, Sao Tome and Principe and the Congo (ex-Zaire) has declined over time to be under the nationally set poverty line (Fig. 1, also see Table 3). Small-scale fisher's income shows a significant improvement in Angola, Gambia, Nigeria and Sierra Leone, while despite being well over the poverty line, it dangerously declined in the Congo (Brazzaville), Côte d'Ivoire and Morocco. In addition, existing disparities in the fisher's income from one country and another may be due to many factors including the ex-vessel value, the species targeted and the market. Large pelagic species caught in countries with a narrow continental shelf (e.g., Cape Verde) may result in higher revenues in comparison with small-pelagic species that are aimed at local markets in other countries (e.g., Congo ex-Zaire).

It is worth mentioning that the average West African fisher household comprises 6 people, which means that each member of the household receives a net benefit of 1.38 USD person⁻¹ day⁻¹, which is below the average national poverty line of 1.9 USD person⁻¹ day⁻¹ estimated herein. Thus, if one assumes fishing is the main activity of the household, this dangerously threatens the livelihood of some 5.9 million people in West Africa.

4.4. Economic impact of West African small-scale fisheries on the economy

Each dollar produced by the small-scale fisheries of West Africa injects 4.3 USD into the economy. Thus, the total current total landed value estimated at 3.42 billion USD generated a potential economic output of 14.7 billion USD of which 43% was generated by the unaccounted value. The latter could generate potentially 6.3 billion USD output towards the economy of West Africa. The total value injected by small-scale fisheries to the economy is equivalent to 6% on average of the 2010 gross domestic product (GDP) of the 22 West African countries. Higher resolution

Table 3
Profitability and fisher's income from West African small-scale fisheries.

Country	Net income USD·day ⁻¹		Fisher's income USD·day ⁻¹		Profitability %		Total costs USD·month ⁻¹		NPL (USD·day ⁻¹)
	Past	Present	Past	Present	Past	Present	Past	Present	Present
Angola	10.6	62.7	1.9	8.2	44	58	121.1	43.6	1.6
Benin	34.3	29.8	5.7	5.7	49	47	46.8	122.4	2.5
Cameroon	12.6	25.3	1.4	5.8	46	53	65.1	142.1	4.9
Cape Verde		816.5		35.3		48		691.0	1.1
Congo (Brazz.)	384.8	224.0	53.5	31.2	59	59	80.2	79.9	1.6
Congo (ex-Zaire)		0.5		0.2		20		46.6	2.8
Equatorial Guinea		9.2		3.2		48		96.9	2.0
Gabon		4.9		1.0		46	69.8	69.8	1.8
Gambia	33.0	48.3	4.9	19.4	56	56	70.8	45.5	2.0
Ghana	112.8	27.9	6.9	1.5	63	45	11.0	523.0	0.7
Guinea	15.0	4.1	2.1	1.7	29	5	793.2	1790.0	2.7
Guinea Bissau	9.8	9.4	0.6	0.6	68	68	66.9	62.2	1.1
Côte d'Ivoire	41.2	46.1	9.5	5.9	42	41	1.1	34.2	1.1
Mauritania	7.3	1.1	3.0	3.1	11	3	1355.3	802.8	0.9
Morocco	85.5	54.5	28.2	5.6	67	49	157.2	811.1	1.4
Namibia		0.4				5		280.2	
Nigeria	0.9	4.7	0.2	3.8	34	48	27.3	9.2	1.6
Sao T.& Princ.		2.4		1.5		40		53.7	3.1
Senegal	92.2	30.1	7.6	13.5	55	35	28.5	38.9	1.5
Sierra Leone	19.0	44.0	5.8	18.0	40	43	174.2	98.1	1.3
Togo	51.2	28.8	4.6	2.3	49	49	86.9	35.6	2.2
Liberia		46.1		5.9		41		58.0	1.3
Average	60.7	69.1	91	8.4	47	41	197.2	269.8	1.9

estimates (per country, see Table 3) show that this contribution is highly variable (66% variability range). Indeed, the lowest contribution to GDP (less than 1%) was observed for Gabon, Equatorial Guinea, Congo (ex-Zaire) and Namibia. The highest contribution to GDP was estimated for Sierra Leone with almost 40%, Cape Verde with 24% and the Gambia with 20%. Results show also that the contribution of small-scale fisheries to GDP was in countries with no fishing tradition (e.g. Mauritania, Liberia) higher than countries with a fishing tradition such as Senegal with only 3% (Table 4).

5. Discussion and conclusion

This paper is the first to attempt a comprehensive assessment of the contribution of West African small-scale fisheries to the economy and how this, through employment and income generation, relate to poverty and thus food security.

Overall, small-scale fisheries of West Africa employ 1.7 million people compared to 1 million fishers estimated officially (FAO, 2009). The reason behind this discrepancy lies in the inclusion in the present study of subsistence fishers as the bottom-up

Table 4
Contribution of small-scale fisheries to the economy of West Africa (2010).

	Revenue (Million USD year ⁻¹)	Economic multiplier	GDP billion (billion USD year ⁻¹)	Total value (Million USD year ⁻¹)	Contribution to GDP %
Angola	360.9	1.37	82.5	494.4	1
Benin	27.1	3.14	6.5	85.2	1
Cameroon	126.4	1.31	24.5	165.6	1
Cape Verde	128.2	3.14	1.7	402.4	24
Congo (Brazz.)	200.1	1.31	13.1	262.2	2
Congo (ex-Zaire)	1.6	1.39	13.1	2.2	<1
Equatorial Guinea	24.0	1.30	12.3	31.2	<1
Gabon	13.0	1.31	14.5	17.0	<1
Gambia	60.1	3.15	1.0	189.4	20
Ghana	341.6	3.15	39.2	1076.0	3
Guinea	63.1	3.14	4.7	198.0	4
Guinea Bissau	14.9	3.16	0.8	47.1	6
Côte d'Ivoire	70.3	3.15	22.9	221.5	1
Mauritania	141.8	3.15	3.7	446.8	12
Morocco	635.5	1.10	90.8	699.1	1
Namibia	0.6	1.10	11.0	0.6	<1
Nigeria	477.2	18.23	228.6	8700.1	4
Sao T. & Princ.	7.9	1.30	0.2	10.3	5
Senegal	339.3	1.20	12.9	407.2	3
Sierra Leone	332.0	3.15	2.8	1045.7	38
Togo	9.2	3.15	3.1	28.8	1
Liberia	42.3	3.14	1.3	132.7	10
Average					6

estimation of the number of artisanal fishers resulted in a number slightly (10%) lower than official estimates.

The increasing number of total people relying on fisheries from 16% of the coastal population to 18%, i.e., 2% per decade, illustrates the important role that fisheries play in West Africa as local populations escape climate-induced failing agriculture and move to the coast (Sarr, 2008). On the other hand, while the contribution of small-scale fisheries to employment is increasing, the landed value, as well as the contribution to the GDP, has been decreasing during the last few years. However, an overall low contribution to GDP does not undermine the important role that small-scale fisheries play in West Africa because of the lack of alternative livelihood opportunities. Indeed, in Gabon, the Congo (ex-Zaire) and Equatorial Guinea where the contribution to GDP was low (mainly because of the under-developed nature of fisheries), almost half of the coastal population relies on fish for their food and livelihood, despite fishers income being below or dangerously approaching the poverty line. This suggests that the key role of fisheries does not lie in their cash value contribution to the economy at large, but rather in its use as a safety net for established and new fishers and their families (Béné, 2006; Béné et al., 2007).

Also, as opposed to a general perception, the income received by small-scale fishers is generally above the poverty line, as also noted by Pauly (1976) for lagoon fishers in Ghana. However, environmental degradation, e.g. over-exploitation, resulted in the expansion of fishing effort and costs as illustrated above, thus leading to declining fishers' income in 50% of the cases. This in turn has resulted in the average fisher's income approaching the poverty line.

At a glance, it appears “small-scale fisheries can generate significant profit” (FAO, 2003) as illustrated by the profitability analysis herein. However, the hypothesis that they can “prove resilient to shocks and crises” and “contribute to poverty alleviation” (FAO, 2003) under the current over-exploitation scheme and other externalities such as illegal fishing is very optimistic, given that their costs are increasing and fishing yield and therefore revenues are declining, leading to declining profitability and incomes (Béné, 2004). Indeed, it appears “shocks and crises” in West Africa have surpassed the threshold that would allow further resilience in the only region of the world where hunger and poverty are worsening (International Food Policy Research Institute, 2002).

The present study illustrates the important role that small-scale fisheries play in West Africa, through employment generation, income, and contribution to the overall economy. Despite being currently profitable, their declining catches, economic contribution and increasing costs adds a twist to the struggle of artisanal fishers facing over-exploitation and increasing illegal fishing (Belhabib et al., 2014b). To overcome this situation, countries of West Africa could invest in more efficient Monitoring Control and Surveillance (MCS) strategies to tackle illegal fleets in their waters. MCS has significantly improved recently in artisanal fisheries in Sierra Leone, which are already showing improvement through increasing income and profitability as cost of fishing is decreasing (Belhabib et al., 2014a). In addition, the protection of coastal areas where small-scale fishers operate implies that the banning of any fishing gear that is harmful to the ecosystem such as bottom trawlers could be helpful. Thus, areas exclusively reserved for artisanal and subsistence fisheries should be created, extended and/or protected in West Africa. Another strategy would be to monitor the growth of artisanal fisheries to ensure that they do not expand unchecked as that would result in overcapacity and overfishing (e.g. in Senegal). Finally, the creation of community based MPA may work towards limiting the artisanal effort, and thus reducing the cost of fishing. These MPAs have to be properly controlled and their socio-economic effects properly monitored.

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Appendix A. Supplementary data

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