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Report of the

Workshop on Climate Proofing Aquaculture in sub-Saharan Africa: Review of Policies and Production Systems for Climate Change Resilience

Addis Ababa, Ethiopia, 9–10 June 2016

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PREPARATION OF THIS DOCUMENT

This is the final report approved by the participants and facilitators of the validation workshop "Climate Proofing Aquaculture in sub-Saharan Africa: Review of Policy and Production Systems for Climate Change Resilience" held at the FAO-SFE office, from 9-10 June 2016 in Addis Ababa, Ethiopia. The materials in the appendixes are reproduced as submitted.

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ABSTRACT

Regionally across sub-Saharan Africa (SSA), aquaculture is a rapidly growing industry with its practices and operations increasingly more commercialized across the continent. An estimated six-fold production increase, from 55 690 tonnes in 2000 to 359 790 tonnes in 2010 was recorded. This trend is expected to increase as the continent's aquaculture operations develops and industrializes. This inevitable production increase and consequent intensification will predominantly be based on fossil fuels. The Norwegian Ministry of Foreign Affairs and the FAO have entered an agreement to improve the implementation and management of existing critical climate change gaps under the global program, "Climate Change, Fisheries and Aquaculture: testing a suite of methods for understanding vulnerability, improving adaptability and enabling mitigation" (GCP/GLO/322/NOR). This series of projects aims to improve global understanding of climate change impact on fisheries and aquaculture development and highlight regional climate change adaptation measures taken on food systems and food security across the Africa region. Together, the Consortium of International Agricultural Research Center's WorldFish and FAO-RAF (Regional Africa Office) have conducted an assessment of the region's aquaculture development and climate change impact adaptation status under two project scopes: (i) a policy review; this component presents a diagnosis of the existing/non-existing African climate change policies related to aquaculture, the sector's resilience and aims to lay bare a regional overview. (ii) a vulnerability assessment model exercise; this exercise utilizes numerous datasets (i.e. meteorological, aquaculture, and socio-economic variables) and inputs from country representative deliberations from a validation workshop. The exercise simulated the vulnerability of regional pond aquaculture systems to climate change impact, however it was agreed that due to data gaps at the country level, the deliberated simulation conclusions were not conclusive and unable to guide climate change adaptation policies. More importantly, the process highlighted what was required at the national level to make more realistic and conclusive assessments for tangible adaptation policies. Together, the policy review and the vulnerability assessment tool demonstrated the required country level actions necessary to prioritize action areas to develop and put in place climate change impact strategies.

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ABBREVIATIONS AND ACRONYMS

COP	United Nations Climate Change Conference COP21
FAO	Food and Agriculture Organization
FAO-GEF	Global Environment Facility
FAO-RAF	Food and Agriculture Organization Regional Africa Office
INDC	Intended National Determined Contributions
NADP	National aquaculture development plan
NAPA	National Adaptation Plans of Action
SSA	sub-Saharan Africa

1. INTRODUCTION

Aquaculture is a rapidly developing subsector and its operations are becoming more commercialized across sub-Saharan Africa (SSA). Several African nations have drafted and implemented national aquaculture development plans (NADP) to encourage growth, and intensification of aquaculture production systems and value chains. As aquaculture production systems across the continent develop, particularly in key production regions such as Eastern Africa and Western Africa (e.g. Nigeria, Uganda, Ghana, and Zambia), its long-term sustainability are questioned. Sustainable aquaculture development requires a knowledge-based approach that draws from global lessons and experiences. Aquaculture systems in Latin America and Asia are exemplary for the mitigation processes of reducing the detrimental consequences from poorly coordinated aquaculture management to cope with climate change.

For farmers across Africa, particularly the more vulnerable small to medium scale farmers, increased climate change vulnerability means changes in final production output. Despite a relatively high aquaculture growth rate in the Africa region, farmers are exposed to climate change impacts. The trend provides an indication on the regional future of the aquaculture sector and its importance to food and nutrition security. Where in 2010, a six-fold production increase of 55 690 (2000) to 359 790 was observed. This highlights the urgency for SSA countries to review and update aquaculture systems and its adaptation policies for countries to act on the implementation of an adaptive, rather than re-active aquaculture sector.

Aquaculture's entire value chain from "farm to table" depends heavily on fossil fuels as the primary energy source; this is even more so in the case of SSA where access to renewable energy sources is limited. While fossil fuels will remain the dominant energy source pushing SSA's agricultural development, agricultural and aquaculture mechanization will occur simultaneously, particularly in Africa, where 80% of farm activities are done by hand-tools. Therefore, it is highly probable that aquaculture development will contribute in increasing atmospheric CO_2, but more so, aquaculture farmers and their operations will be affected by climate change impacts. Further, dynamics such as Africa's stagnating inland fisheries, high population, increasing population growth rates, rural nutrition deficiencies and a high demand for animal protein emphasizes the importance of aquaculture's contribution to regional trade and food/nutritional security. For this, a resilient aquaculture sector is needed.

NADPs target the intensification and industrialization of aquaculture systems and value chains, but seldom include long-term climate change adaptation plans and climate change risk assessments aimed at putting in place policies and systems building long-term resilient systems. Efforts on the long-term sustainability of aquaculture growth must be considered at the farm production level, whereby climate change impacts are influential, and at the policy level that encourages sustainable systems that are resilient to climate change impacts. With resilient systems in place the necessary environment is established to stimulate positive regional competitive markets and trade.

The Norwegian Ministry of Foreign Affairs and FAO entered an agreement, dated 10th, December, 2010 under the global program, "Climate Change, Fisheries and Aquaculture: testing a suite of methods for understanding vulnerability, improving adaptability and enabling mitigation" (GCP/GLO/322/NOR) with the target to improve the implementation and management of critical climate change gaps. To analyze impacts at the Africa region, WorldFish and FAO-RAF conducted a regional diagnostic that highlighted the region's current aquaculture status and climate change impact adaptation measures under two corresponding components:

1) **Vulnerability assessment***:* through the incorporation of datasets (i.e. meteorological, aquaculture and socio-economic variables) a climate change vulnerability exercise was conducted using an indicator-based model. This exercise will a) highlight the steps and methodology required to conduct a vulnerability assessment model and b) project the generated degrees of climate change impact vulnerability for African countries in relation to an identified aquaculture systems.

2) **Policy review:** to further the diagnosis of African aquaculture and obtain a better understanding of where climate change adaptive policies exists in Africa, the project conducted a policy review related to climate change adaptation and aquaculture. This component aimed to establish what measures exists and do not exists, what policies re currently being implemented, and what policies require revisions across the SSA region.

As the output of the two above-mentioned components, the project conducted a validation workshop held in FAO-SFE (East Africa Office) Addis Ababa, Ethiopia on the 9th - 10th June 2016. Agenda in Annex *2*. The workshop deliberated and appraised the vulnerability model and policy review diagnostics initially performed by WorldFish. With the contributions of the 14 country representations and FAO resource persons (see Annex 13 for workshop participant list), the workshop conducted the following:

- **Appraisal of policy review***:* as part of the overall project, the policy review component aims to improve the understanding of the current policy statuses of climate change resilience across the Africa region. It is therefore critical to incorporate country representation inputs, drawing from their accounts of national policy status in relation to aquaculture development and climate change adaptation. This component presented the initial policy review conducted by WorldFish and FAO-RAF to the participating country representatives at the workshop and opened the discussions to examine what policies exist and are lacking.

- **Appraisal of vulnerability assessment indicators:** the vulnerability model required inputs from individuals with knowledge and experiences at the country level. Country participants were invited to the workshop to 1) deliberate and agree on the categories and variables used in the vulnerability assessment for aquaculture and climate change vulnerability and 2) discuss the possible points of improvement on the applied data sets and its possible implications for African countries. For the outcome of the initial simulation, with equal indicator weighting, see Annex 10.

2. DAY ONE

2.1 Opening of the workshop

The fishery and aquaculture officer of FAO-RAF, Martinus Van der Knaap opened the workshop and welcomed the participants. The opening statement highlighted the challenges that African fisheries and aquaculture face and gave extra attention to the lack of climate change adaptation and long-term resilience measures in the planning process across the region. The opening statement then presented the purpose of the workshop and the efforts of FAO, in collaboration with WorldFish to conducted a preliminary indicator based aquaculture policy review and vulnerability assessment at the SSA region.

The opening statement brought the participants' attention to the historic agreement in Paris, France at the 2015 United Nations Climate Change Conference COP21. This conference announced the commitment that nations will take to address climate change impacts at a global scale and the workshop highlighted to participants this opportune time to build on climate change resilience in aquaculture for the Africa region. It was also declared that, based upon a FAO review in 2013 of the short-term National Adaptation Plans of Action (NAPAs) that significant knowledge and action gaps existed in the Africa region with regard to climate change adaptation in the aquaculture subsector.

The opening statement closed with the statement that several SSA countries are at different relative stages of their aquaculture development and its planning process. The statement highlighted the importance of aquaculture in fulfilling unique roles in livelihoods, community health, nutrition, regional trade and food security. With this, the workshop started its programme in the discussion and deliberation process drawing from country experiences and their unique aquaculture dynamic to mediate statuses. This will help to contribute in the policy review and the vulnerability assessment exercise to examine the steps forward in building a more resilient aquaculture sector for the region. For the full opening statement see Annex 1.

2.2 Country reporting - aquaculture and climate change adaptation statuses

Following the opening statement, all country participants presented an overview of their respective aquaculture sector based on operational experiences. Three main points were requested to be presented by the participants to provide a brief of the sector, they included: 1) main aquaculture production systems, 2) production situation and 3) climate change adaptation status. Table 1 represents participant overviews of their respective aquaculture sector.

Table 1 – Aquaculture sector and climate change adaptation overview from workshop participants

Country	Main aquaculture production systems	Aquaculture production status	Perception on climate change impacts on aquaculture	Closing Remark
Benin	- Chiefly lake systems based on water tables - Aquaculture infrastructure around reservoirs and earthen pond systems (other systems include: plastic lining, wooden tanks, and tarpaulin; mainly around urban areas) - Floating cages system exists - Enclosed production systems in shallow water are operational - Dug-out systems for fish, e.g. in water reservoirs created for agriculture purpose also exists - Capture fisheries declared to be over exploited - Main cultured species: African catfish, tilapia; production of monosex fingerlings with technical support (from Egypt) is operational.	- 2009: 308 kg - 2013: 1 489 kg - 2015: No information	- 2015: observational climate change impact to fresh water supply was a detriment to aquaculture production. *E.g.* many earthen ponds have dried up, water shortages have impacted community agriculture and aquaculture production, deficit in water supply also reduced local aquaculture feed production and increased market prices.	- Benin's main focus is on improving aquaculture production. A development strategy should however be adaptable to have resilience that can also increase production. The national aim is to improve production two folds and address the trade issue of imported fresh and frozen fish into Benin.
Democratic Republic of the Congo	- Aquaculture operations limited to earthen ponds only - 80% at the subsistence level with fish feed coming from agriculture operations - Minority (10%) of the operations are at the industrial level using imported feeds - Local fish feed producer – not available - Government strategy aims to maximize the huge aquaculture potential in the country - 2009 Strategy Plan – drafted but not yet fully disseminated - Main culture species: Catfish and various indigenous species.	- Difficult collect reliable and regular aquaculture production data - FAO (2005): 3 000 tonnes	- Currently, a national plan for climate change adaptation for 2 zones in draft: west-north and central-west to address the high precipitation levels and improve access to useable water; - Tropical climate zones: with observed reduced rainfall and drought (in the south and south-west zone) where 60% of the population live and are highly dependent on agriculture.	- A focus must be placed on a plan and strategy to elaborate climate change mitigations measures. - Initiate study of climate change impacts and aquaculture to adopt suitable actions.

			- Climate change to impact agriculture production, which is the main feed source to aquaculture operations. Feed prices will fluctuate.	
Ethiopia	- 1960 – aquaculture research center established with support from Japan, now 4 research centers in different regions across Ethiopia. - 2009 – drafting of a national aquaculture strategy - Currently, aquaculture is underdeveloped with low production levels - Extensive pond system (i.e. 200-300 m^2) are operational across Ethiopia - No commercial production operations in fish farming - No formal hatchery, seed and feed producers - One foreign owned production facility using imported tilapia fingerlings from Kenya - Some systems of integrated aquaculture and vegetables production in more arid regions - One trout farm operating (private level, commercial operation) - Main culture species: Striped Catfish, African catfish, and tilapia.	- Inland fisheries: 60 000 tonnes from reservoirs, dams and lakes - Aquaculture production 2015: 25 tonnes.	- No definitive observations from climate change impacts on Ethiopia's aquaculture yet. - Subsistence aquaculture operational in river banks; possible constraints on water availability - Seasonal changes: significant conflicts in water use, both upstream and downstream; livestock, agriculture sector conflicts. Water shortages predicted for fish farming - Rift valley lakes – lower water table levels - Seasonal flooding creates run-off and increases siltation impacting fish production - Intense rain and sunlight damages concrete ponds	- National government invested resources to establish a formal commercial hatchery - JICA has provided resources to NGOs aimed at community feed-farming projects with aquaculture a focus.
Ghana	- Extensive, semi-extensive, intensive fish-farming operations occur at different capacities across Ghana. - Mainly fresh water based, no marine and brackish (chiefly all try-outs) operations	- 2015: 44 000 tonnes of aquaculture production - 2010: 10 000 tonnes of aquaculture production	- Water levels for lake operations have dropped - Cages: before 376 meter depth; now 314 meter	- Ministry has a national policy and strategy in place to manage aquaculture.

	- Ghana's northern region is dry, with some construction of small reservoirs to stock water. Tilapia farming occurs with feed dependent on local natural sources. - Main culture species: [Extensive] mixed species all tilapia (e.g. *heterobranchus*) and poly culture with wild stocks. - Ghana has strong research institutions that collaborate with WorldFish to obtain faster growing tilapia (i.e. 30% faster growth rate after 11 generations). Many local farmers use this local broodstock. - Fish is an important source of protein in Ghana (much of it is from marine sources, 50%).	- Fast growth rates in the sector - Numerous fish cages on Lake Volta - Fish feed: two commercial producers (floating feed). Intensive operations solely dependent on commercial feed. Extensive operations use fertilization from pond water; yield generally very low.	- Fish cages moved to deeper depths to reach sufficient dissolved oxygen levels - Climate change impacts influence the lack of sufficient water supply for aquaculture operations; water levels reduced for earthen pond operations.	- Aquaculture seems to be overregulated and under enforced.
Kenya	- Commercial scale operations observed in Western lake regions for both pond and cage operations - Inland pond operations exits in central areas. Local county governments introduced agriculture co-operatives (dairy) where as a result aquaculture production occurs (e.g. ponds of 300m^2 and integrated systems) - Main culture species: various tilapia species, catfish and some ornamental.	- Regular and reliable aquaculture production data is lacking	- 2 operational seasons in production cycle: - drought in 2015 observed for many sectors in central region, many fishponds have dried up. - Intense rains have washed fish and fingerlings out from their ponds.	
Malawi	- 2015: 6 000 small-scale fish farmers at pond production level recorded - Key partners: WorldFish, FAO, USAID, Chinese Investors, JICA, OXFARM, WorldVision that support aquaculture developments - National fish and aquaculture policy drafted in 2001 and National aquaculture strategy plan in place (ended last year 2015) - NAPA with two areas on fish farming and promoting aquaculture is currently being revised - Main culture species: Nile tilapia and Mozambique	- 2015 aquaculture production at 14 000 tonnes.	- Most ponds (70%) located at low-lying areas and were flooded - Droughts have resulted in ponds (40%) drying up - Poor growth of cultured species observed - Feed imported (e.g. from Asia) has increased in market price.	- Public Private Partnership model aims to improve aquaculture integration in many industries - Limited access to extension services observed at the ground level.

	tilapia.			
Niger	- Much of the aquaculture operations are pond setups: plastic sheeting in ponds, cement ponds, ponds created during rainy season (especially for tilapia farming). - Floating cages operating since 1992 - Receive support from World Bank to develop aquaculture - Fish Feed: flour-based, agricultural fertilizers. Some commercial feeds imported from Nigeria - Constraints: extension support and challenges with regular access to quality feeds - Main culture species: tilapia and African catfish	- Regular and reliable aquaculture production data is lacking	- Extreme temperatures (up to 40 degrees Celsius) have been observed - Increased floods and storms impact vulnerable small scale farmers, especially ponds - Ground water levels continually dropping - Tilapia production: constant changes in production cycles decrease production level. Farmers earning less from smaller sized fish. - Imported fish from Asia have increased to meet local demand - Weak support to local producers to cope with climate change impacts have resulted in abandoned ponds.	- An urgent need is required to setup and implement different strategies and actions.
Sierra Leone	- Marine fisheries – extensive in northern parts of the country, high potential for marine aquaculture. - 4 physical regions – mountainous, coastal, lowland flood plains (high potential for aquaculture), mixed mountain and lowland - Coastal region has more fresh water supply coming from the mountainous areas - 1975: oyster farming introduced by Canadian	- Regular and reliable aquaculture production data is lacking.	- Climate change impacts marine aquaculture: detrimental impact to production, loss of local farmed species; - 2 seasons in Sierra Leone (wet and dry) - Farmers harvested tilapia	- Aquaculture is at the small scale– lack of profitability, needs financial boosts, no fingerlings production. - A need to explore local ingredients to produce feeds to develop the sector

	investors. Inland aquaculture infrastructure and feed production was established but short lived due to lack of availability of fingerlings and feed. - Civil conflict resulted in many aquaculture operations being abandoned. Facilities now converted for agriculture purposes - Government focuses on aquaculture rehabilitation of stations. Private sector investments occurring. - WorldFish to support Makeni aquaculture field station - Njala University, Freetown has a technical aquaculture programme. - 600 registered fish farmers in Tonkolili, small-scale ponds.		earlier due to unreliable water availability (dried water sources in 2015) - Sierra Leone has limited meteorological stations and no early warning systems - The Fisheries Act lacks a climate change component - Five-year plan is being developed, taking into considerations to climate change adaptation developed by Ministry of Environment	in Sierra Leone - Micro-finance opportunities and its development would benefit small scale fish farmers.
Uganda	- Earthen ponds is the main system (around 25 000 registered ponds) - Cage systems also operational (mostly the 5x5x2m type) - Tank systems also present - Around registered 15 000 fish farmers across Uganda - 4 public hatcheries operated by the government - Around 20 large-scale fingerling production facilities present - Dams, reservoirs, and small lakes significant to the sector in Uganda - Few fish feed companies (one local and two international) established. Consequently, feed prices have fluctuated - Main culture species: African catfish, Nile tilapia, carps, Chinese carp, and bighead carp at reservoirs and small lakes.	- Significant increases in cage production - 2015: 50 000 tonnes in total aquaculture production	- Two seasons: Rainy (Mar-May) and dry (Jun-Jul) in Uganda. - Intense rains have caused higher flood rates, colder water temperatures have reduced total fish grow out sizes during production. - Intense evapotranspiration makes farmers harvest earlier with smaller total lengths. - Faster wind speeds and storm rates damage farm infrastructure.	- Uganda's capture fisheries has decline tremendously - Government has focused on improving aquaculture and supporting fish farmers - Aims to establish a Department fully committed to aquaculture - Significant support and emphasis on the private sector.
United Republic of Tanzania	- Most operations are at the small-scale level, mainly in earthen ponds - Key hatchery in Morogo produces fish fingerlings to	- Freshwater: mostly at the small-scale level at low production values	- Lake Victoria and lake Natron: overall lake surface area has reduced	- Few measures discussed nationally to address and build climate change

	fish producers on the mainland - Few research institutions for research, development and training for hatchery operations and aquaponics exists. - Integrated systems (combination of chicken, fish and vegetable systems) are mostly at the research and private level stage. Not at the commercial level yet. - Marine aquaculture is significant in United Republic of Tanzania. This includes finfish production and sea-cucumber (mostly private level in pens and enclosures), crab fattening, and carp production (mostly private and research levels) - Since 1989, seaweed aquaculture has been operating at a more commercial level, specifically in Zanzibar. With international trade taking place. - Main cultured freshwater species: tilapia (key species), Mozambique tilapia, and African catfish (small-scale).	- Marine: 5 000 tons of finfish production (milkfish, mullet and rabbit fish). Figure also includes sea cucumber, shellfish and oysters production. - Seaweed: production gradually increasing. 808 tonnes in 1990. Export value of 15 000 tonnes of dry seaweed in 2012 and 13 000 tonnes in 2013.	- Groundwater levels for freshwater fish ponds have decreased - Seaweed production decreasing due to rising water temperatures - 2 types seaweed: *Spinosum* (0.25$/kg) and *Contonii* (higher value 0.5$/kg) production has reduced due to climate change impacts. - Food and feed: now freshwater producers depend more on poor quality homemade feed. - Marine: 1989-90 mostly local produced feeds (no commercial hatchery exists; however, project with FAO and KOICA sets to develop this facility.	adaptation measures to support production increases. Main focus is improving production.
Zimbabwe	- Developed infrastructure for aquaculture operations - Around 10,000 small scale farmers operating around dams and floating cages - Food & recreational trout production operations also observed.	- 90% from Kariba dam (2 700 tonnes total and 2 300 tonnes of Nile tilapia from floating cages)	- Drought: water level drops have impacted small-scale fish farming significantly - Climate change projections suggests that Zimbabwe will have less rainfall and more drought - Strategy for water management, improve community adaptive capacity, capacity building needed.	- Ministry aims to make Aquaculture more industrious in the National Adaptation Plan.

2.3 Likely impact of climate change impacts on aquaculture

The workshop then progressed with a presentation conducted by WorldFish project leader, Malcolm Dickson. In this presentation the fundamentals of climate change impacts on aquaculture operations were presented. Pertinent points such as global warming patterns, sea level rise (i.e. 40-100 cm in this century) in coastal countries, changes in ocean circulation (El Niño and La Niña fluctuations), increases in monsoon frequency, water stressors, changes in hydrological regimes and extreme weather events (FAO, 2009) were presented and discussed amongst participants[1]. The participants were also given a break down of the Intergovernmental Panel on Climate Change 5th Assessment Working Group II report drafted in 2014 that eluded the socio-economic impacts of climate related effects to agriculture systems. The presentation finished with an overview and discussion on a case study on Egypt. For the presentation link see Annex 3.

Upon the closing of the first presentation, the floor was open for participants to share country experiences on the issues aquaculture faces in light of climate change impacts. Examples from United Republic of Tanzania were discussed and this included cases of salinity intrusions into fresh water aquaculture operations and the increased tidal force on marine aquaculture operations. Indian Ocean nations in eastern Africa were also likely to experience the same generic climatic conditions impacting the aquaculture sector. Through out the discussions, several participants raised the question of how to better *quantify* climate change impacts in upland areas that are overlapping with agriculture and prone to flash floods as a result of increased human activity. As a result of the discussions, it was agreed that the most current, common and pertinent aquaculture operations across SSA are inland earthen ponds that have a greater impact to rural livelihoods.

Attention was brought to the possible opportunities that climate change may have on aquaculture production through specific examples. Most notably, farming of higher value species (i.e. *Penaeidae* shrimps) in coastal areas with increased brackish water levels was discussed. However, the consensus was that, at the Africa region, an overall need for improved management to put in place medium to long term adaptation measures was required as many existing key systems (e.g. earthen ponds, lake cages, integrated systems, and reservoirs) lack adaptation measures to cope with climate change impacts for farm production purposes.

2.4 Policy review

An overview of the Intended Nationally Determined Contributions (INDCs) as an outcome of the COP21 was presented to the participants to open discussions and provided a situational understanding of current global climate change adaptation statuses specific to the Africa region. The INDCs identify and demonstrate national commitments to limit carbon emissions by 2020 through documentation of country level actions. Further, in addition to the declared mitigation measures, many countries have also highlighted the importance of adaptations actions (across

[1] FAO 2009. *FAO Fisheries and Aquaculture Technical Paper*. No. 530. Rome, 212p. (http://www.fao.org/docrep/012/i0994e/i0994e.pdf)

different sectors, not only limited to fisheries and aquaculture), mitigation options, dedicated funds (government allocated and/or external funding) as part of the entire INDC process[2].

For workshop purposes, workshop facilitators probed the country participant's statuses in regards to the INDCs to see if any actions are taking place. It was agreed that regional information and legal documents on climate change adaptation policies were lacking, let alone did they include aspects of fishery and aquaculture developments across the Africa region. This process, for workshop purposes only, presented the documented declarations from countries that attended the workshop and the initial policy review and are presented in table 2.

Table 2 – Current national policy status on climate change adaptation measures and aquaculture developments

Country	National aquaculture development plan present?	Degree of inclusion/mention of climate change adaptation in NADP	National climate change adaptation plans present? Degree of inclusion / mention of aquaculture	Remarks
Angola	Yes	No	No	INDC – discussed impacts of climate change on fisheries
Benin	No			Climate change adaptation and aquaculture development will be considered in the development of the plan
Chad	No	No	Has a NAPA since 2009, but not yet implemented	Aquaculture as an adaptation measure in the INDC
Democratic Republic of the Congo	Yes	No	Has NAPA (2006) and a UNDP climate change Adaptation Programme (2010-2012)	
Equatorial Guinea	No	No	No	
Ethiopia	Yes	No mention of climate change		New Ministry of Livestock and Fisheries and no separate aquaculture policy (within agriculture)
Gabon	No	No	No	
Ghana	Yes	Only a single reference to climate change impacts	Yes. No specific mention	Aquaculture is an alternative livelihood system to diversify incomes
Kenya	Yes	Mentioned only the risk of the climate change. No adaptation.	Has climate change action plan for agriculture, but not specific to aquaculture	
Malawi	Yes	No	National climate change policy exists, but no	Aquaculture operations are an adaptation measure for

[2] INDCs: http://www4.unfccc.int/submissions/indc/Submission%20Pages/submissions.aspx
NAP Portal - case studies, best lessons and National Adaptation Plans (http://www4.unfccc.int/nap/Pages/Home.aspx)

			mention of either aquaculture or fishery	livelihoods
Mali	No	No	Has a programme to mobilize finance to adapt to climate change impacts	Aquaculture is an adaptation measure
Mozambique	No *(under development)*	No	Has a national climate change strategy (2012)	
Niger	Strategy in 2006 for all aquatic resources		No national plan yet	
Nigeria	Yes	Only mention of climate change in the "risks" section of document	Yes. No specific mention	Aquaculture as an adaptation option for fishing communities to cope with climate change impacts
Rwanda	Yes	No (only mentions climate variability, not climate change impacts)	Strategy on climate change and Low Carbon Development, but no mention of aquaculture and fisheries	
Sierra Leone				Currently under going a review of fisheries Act to include climate change and aquaculture components within it
United Republic of Tanzania	Yes	No	Has climate change strategy (2012) and Resilience Plan (2014), but no mention of aquaculture	
United Republic of Tanzania	Fisheries policy act, strategy and plan being developed		Yes. Little to no mention of aquaculture	
Uganda	Yes	No	Has climate change policy, aquaculture as an adaptation policy	
Zambia	Yes	No	Yes. No specific mention	
Zimbabwe	-	-	Has national climate Change Response Strategy (2013), does not mention aquaculture	Developing National Policy and Adaptation Plan by 2017

Throughout the presentation and discussion of the policy review process it was agreed by the participants that climate change adaptations, policies and practices for the aquaculture sector was generally lacking for the Africa region. Aquaculture is regularly referred to as an adaptation strategy to mitigate climate change impacts under the form of the fisheries or agriculture sector actions. Although contentious, and not definitive, the overall consensus is that in Africa fisheries

are viewed as the main provided for aquatic based protein. Consequentially, climate change adaptations measures and its awareness at the aquaculture sector remains weak, despite its relatively ease of management (i.e. compared to fisheries), its output for protein production and wider access to markets (e.g. improved accessibility to inland consumers).

Climate smart aquaculture was discussed regularly by participants and facilitators and was presented, as an offshoot of the term, "climate smart agriculture". Climate smart aquaculture entails, for the purpose of this workshop's discussion, the inclusion and practice of 1) water efficient operations relative to the culture species, 2) resource efficiency of aquaculture inputs to overall aquaculture operation (i.e. feed use, its transport, storage, and energy source) and 3) strain on ecosystem services, particularly provisioning and regulating services specific to aquaculture. The discussion on the actual role and impact of aquaculture to climate change was also brought to attention, particularly the roles of aquaculture feed harvesting, production, transport and its contribution to emission of green house gases at the global level. It highlighted the urgency that African based fish farmers should move away from imported feeds and the potential of local feeds. This discussion elicited the conclusion that aquaculture production systems are more adaptable (have a higher adaptive threshold) when capital resources are available at the micro level to deal with the immediate climate change impacts and shocks whether it be at the farm production level or later stages of the aquaculture value chain.

The group recommended that in order for climate change adaptation policies to occur more frequently in the aquaculture development process and it's drafting, recommendations should be more exclusive and more of a stand alone assessment. Compared to fisheries, agriculture, and livestock sectors, aquaculture contributes less to greenhouse gases emission for protein production value. This point is often overlooked as the true extent of aquaculture impact to climate change contributions (e.g. fish feed industry, transportation, and operation overheads) has not yet been investigated, resulting in the mindset that increased production, not sustainability and resilience is the ultimate target of aquaculture development.

Three pertinent points as a result of the policy review discussions included: 1) as of current, the most progressive way to shape African aquaculture to be more climate change resilient is to include climate change adaptation measures into drafted national aquaculture development plans, should they exist; 2) the general consensus is that there is little to no emphasis for aquaculture in regards climate change policies and vice versa and 3) that aquaculture cannot simply be a mitigation option (for agriculture and/or fishery sector) as it's production is directly influenced by climate change factors, contributes to climate change stressors, and overlaps/interacts with other sectors.

2.5 Presentation of the vulnerability assessment tool

To follow up the policy review component, the complementary vulnerability assessment tool and its methodology was presented by Suan Pheng Kam and Shwu Jiau Teoh to workshop participants. They presented the overview of the tool, its applications and its methodology and the indicator maps.

It should be well noted that:

- This methodology does not investigate internal differentiation at the micro level, but rather how the input variables corresponded on a general regional context.
- Therefore, this assessment does not represent country level residuals; it presents continental overview for the SSA region and does not distinguish in-country variations of climate change vulnerability.
- The vulnerability assessment focuses on inland pond aquaculture systems at the small-scale and commercial level, using the country as the basic spatial unit of analysis.

The definition of vulnerability applied in the approach was adapted from Allison (2005) and FAO (2015)[3]. In this particular definition, vulnerability is considered as a combination of three measurable components; 1) Exposure (E); nature and degree to which a countries' aquaculture system is exposed to predicted climate change impacts. 2) Dependence (D); degree to which peoples and economies are likely to be affected by aquaculture-related changes and 3) Adaptive capacity (AC); Abilities and resources of the aquaculture system to cope with climate-related changes. Exposure and Dependence conceptually combine to produce Potential Impact, defined as all impacts that may occur without taking into account planned adaptation. Therefore, vulnerability is expressed as:

$$\text{Exposure (E)} + \text{Dependence (D)} = \text{Potential Impact (PI)}$$

$$\text{Potential Impact (PI)} - \text{Adaptive Capacity (AC)} = \text{Vulnerability}$$

$$\text{Vulnerability} = f(\text{PI, AC})$$

For vulnerability model overview see Annex 4.

When vulnerability definitions were discussed and approved by the participants, WorldFish presented the five processing steps used for this model. They are as follows:

- Step 1: Identify factors, select indicators and proxy variables
- Step 2: Estimate and normalize indicator variables
- Step 3: Determine factor weighting
- Step 4: Conduct multi-criteria evaluation for estimating vulnerability sub-indices and indices

[3] Allison, E.H. (2005). The fisheries sector, livelihoods and poverty reduction in Eastern and Southern Africa. In: Rural Livelihoods and Poverty Reduction Policies. Routledge, London, pp 256-273.
FAO. 2015. Assessing climate change vulnerability in fisheries and aquaculture: Available methodologies and their relevance for the sector, by Cecile Brugère and Cassandra De Young. FAO Fisheries and Aquaculture Technical Paper No. 597. Rome, Italy. (http://www.fao.org/3/a-i5109e.pdf)

- Step 5: tabulate and map sub-indices and overall vulnerability index

WorldFish facilitators then went into a detailed presentation and discussion of the indicators and variables selected for input into the first simulation of the model. The overview of all indicators and variables selected for each vulnerability component are shown in Annex 8.

Prior the validation workshop, WorldFish researchers had conducted a literature review and selected indicators and variables used for the three components mentioned above that define vulnerability (exposure, dependence, and adaptive capacity) suitable for an overview of the SSA region. The selected variables are listed in Table 3 (or see Annex 8 for the graphic format).

Table 3 – Variables and indicators selected for the vulnerability assessment

Variable/Indicators	Exposure (E)	Dependence (D)	Adaptive capacity (AC)
	Variation in long-term annual rainfall (CV)	Aquaculture production	Adult HIV prevalence
	Long-term annual rainfall (mean)	Aquaculture value as % of GDP	Travel time to nearest town over 20K size
	Impacted area due to 1m Sea Level Rise	National per capita fish consumption	Governance index (Rule of Law)
	Desertification risk	Fish consumption relative to protein consumption	Human development index (HDI)
	Drought risk	Stunted children <5 age	Poverty index (below PPP $1.25/day)
	* Water risk	* Population density	Mobile cellular ownership
	* Climate induced extreme events	^ Livelihood dependence on aquaculture	^ Presence of national AQ/CC policy/strategy
	^ Flood risk		^ Weather forecasting services
	^ Temperature rise		^ Aquaculture/agriculture R&D investment

- Data included in the first simulation
- * Additional new data
- ^ Incomplete/no data

Given resource constraints and access to reliable primary information, the datasets used to run the first simulation are based of secondary data sources from various organizations, academic sources, UN agencies, and meteorological services. The indicator variables that were compiled and the associated interpretations of their influence on vulnerability of inland pond aquaculture across Africa are listed in Annex 5, 6 and *7*.

The next step of the exercise was to engage the country participants in determining the relative importance of the determinant factors of vulnerability by weighting their selection of the indicators based on their experiences. The participants were split into two working groups, to conduct the weighting exercise for 1) small-scale (subsistence and semi-subsistence) and 2) commercial (large investment) inland pond

aquaculture[4]. In the SSA context, a 3 000 tonne production threshold (2011 figures) was used to distinguish small- and commercial-scale aquaculture at country level (see (Table 4) and corresponding map in Annex 9).

Table 4 - Small scale and commercial scale aquaculture deliberation exercise groups

Small-scale aquaculture group	Commercial scale aquaculture group
Benin	
Democratic Republic of the Congo	Ghana
Ethiopia	Kenya
Mozambique	Malawi
Niger	Uganda
Sierra Leone	Zimbabwe
United Republic of Tanzania	

2.6 Factor weighting deliberation exercise

In their respective groups participants discussed, selected and deliberated the significance of several variables. These discussions included the variables listed in Annexes 5, 6, and 7, how they interact, how they did not and what other possible factors should also be included when considering aquaculture development and climate change resilience in Africa. At the end of the deliberation process, participants would present their selections and weightings on the examined variables, justify their significance and explain any additions and removal of new variables. The factor weights assigned by the country participants were used to run a second simulation of the vulnerability assessment model and the results were presented and discussed in day two of the workshop.

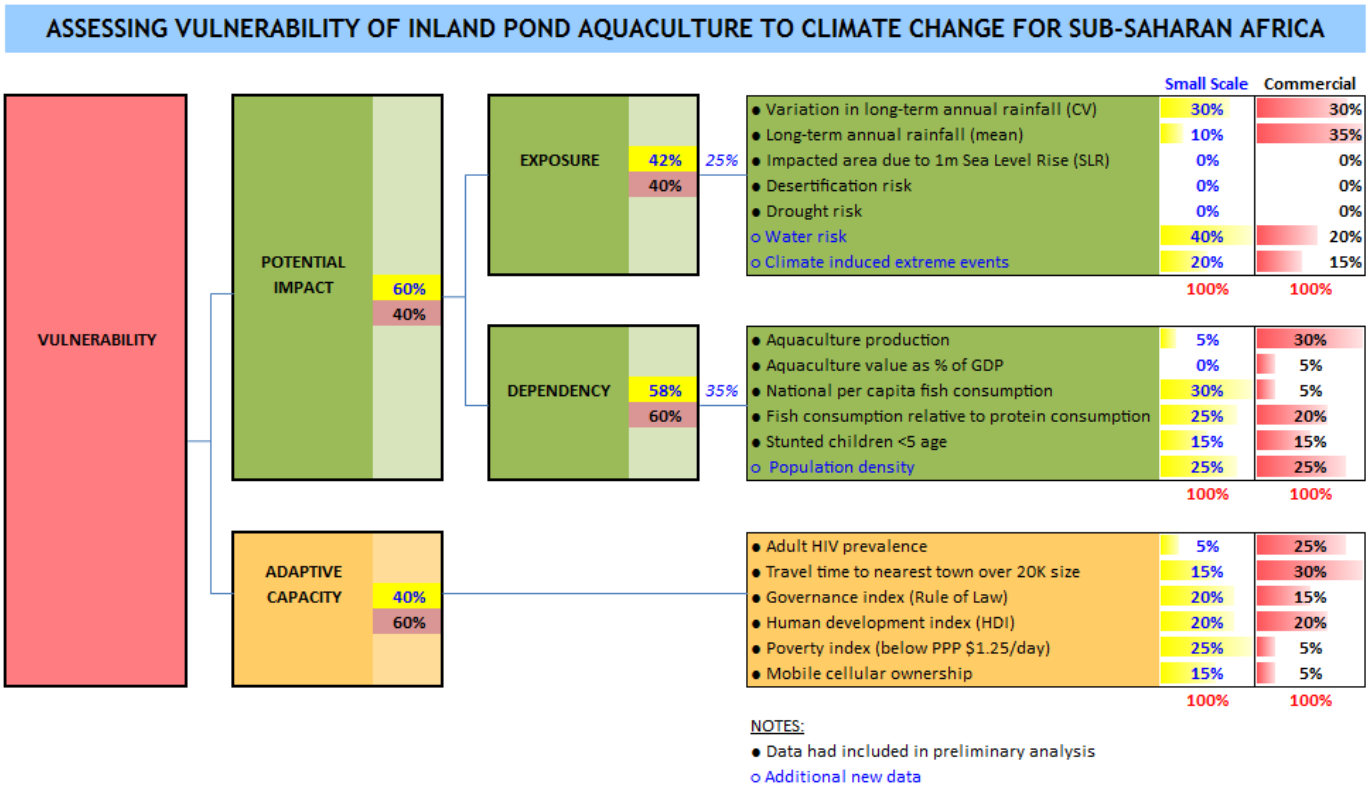
[4] FAO defines aquaculture as: *Aquaculture is the farming of aquatic organisms, including fish, molluscs, crustaceans and aquatic plants. Farming implies some form of intervention in the rearing process to enhance production, such as regular stocking, feeding, protection from predators, etc. Farming also implies individual or corporate ownership of the stock being cultivated. For statistical purposes, aquatic organisms which are harvested by an individual or corporate body which has owned them throughout their rearing period contribute to aquaculture, while aquatic organisms which are exploitable by the public as a common property resources, with or without appropriate licenses, are the harvest of fisheries.*

3. DAY TWO

3.1 Weighting of variable outcomes

To start day two of the workshop, WorldFish facilitators presented the results of the second simulation of the vulnerability assessment model using the weighting variables provided by country participants from day one. Figure 1 compares the weights provided to the indicators by the two groups.

Figure 1 – outcomes of the variable weighting exercise



Overall, the pertinent outcomes of the weighting exercise are (1) the differences under potential impact indicators (exposure and dependence) are not significant (2% difference) between small-scale and commercial aquaculture operations and (2) production and water access factors were given extra attention when considering exposure. Other significant points raised by the participants in regards to aquaculture and its climate change vulnerability assessment included:

- Commercial aquaculture producers put less weighting to water related risks than small scale producers as most large scale operations are conducted in larger water bodies with more steady access to regular water sources (e.g. lakes and reservoirs). This highlighted the importance of site selection and land access rights for inland pond aquaculture operations and its vulnerability to climate change impacts.
- Commercial aquaculture production placed a higher weighting percentage on adaptive capacity in response to the unpredictability of climate change impacts that may impact their final profits and highlighted the need for adaptive capacity measures already be in place to mitigate potential profit losses.

- Small-scale producers placed a higher emphasis in national per capita fish consumption (dependence) and a lower weighting value on final aquaculture production of farmed fish (exposure). This emphasizes the point that rural communities often depend more on direct consumption of fish, as opposed to market sales, as a means of food and nutritional security. That production profits, although important, is not the main focus of aquaculture production in SSA. These dynamics suggest that when conducting vulnerability assessments at the country level, the dynamics for different scales and purposes of aquaculture operations should be considered in a more specified manner.

Generally, workshop participants agreed that exposure variables (climatic conditions) are beyond the control of farmers and considered these influences to be "externalities". However, as small-scale farmers often lack the capital means to deal with impacts, they were deemed more vulnerable to experience climatic related detriments to their production abilities.

To see the results of the vulnerability assessment for small-scale inland pond aquaculture systems see Annex 11.

To see the results of the vulnerability for commercial inland pond aquaculture systems see Annex 12.

3.2 Constraints and improvements to the current method

Several points and issues were raised on ways to improve the climate change and aquaculture vulnerability assessment for the Africa region. It was generally accepted that limitations existed in regards to this specific method with the main constraint being the high data demand of (i) situational variables and (ii) lack of implemented policies in a region that initially lacks regular and reliable information. Therefore, the practicality of the results and its conclusions should not be used in definitive policy formations, but rather a pre-cursor for future country/region specific analysis more suitable to specific NAPs and realistic policy recommendations.

However, the outcomes of this project should go someway to demonstrate the vulnerability of inland pond aquaculture systems in sub-Saharan Africa. Other key points included:

- **Time frame:** issues on the time frame of the tool and its methodology was raised to consider in greater detail what type of analysis this approach would be most suitable for, *e.g.* is it more for a current situational analysis aimed at immediate implementation or more of a long term analysis aimed at building long-term policies and relevant adaptive measures?
- **Context:** as the data derives from secondary databases, this particular analysis can only go so far to assess current vulnerability. However, commercial aquaculture producer group declared that adaptive capacity should focus on long-term measures (over 5 years) to build more resilient aquaculture sectors that will have positive outputs for regional aquaculture trade and commerce. Therefore, based on this simulation, it was agreed that this would be targeted for short to medium term resilience plans as the more suitable application of the tool. As climate conditions will change considerably in the future, it would require different sets of regional and country level projections of climate change variables to have practical ground level relevance to draft tangible national adaptation plans.
- **Application:** This methodology would be most useful for a country level situational analysis at more specific scenarios, rather than a generic continental analysis. It was suggested that baselines be conducted to cover sub-regional (e.g. western, eastern Africa or key aquaculture production regions) systems that provide a better analysis that brings out the areas of aquaculture and climate change concerns into priority for their improved integration into national adaptation plans. The aim is that this

analysis will translate in ground actions. The justification for regular situational analysis is that as exposure and dependence variables are more dynamic than the more human related adaptive capacity variables, clear recommendations would require several case specific examinations, as climate change impacts at the community level are combinations of fringing and/or micro level impacts.

- **Case specificity**: contentions on the final outcome of the vulnerability assessment demonstrated that indicator variables limited to the generic continental level do not fully reflect the true ground situation. For example, Sierra Leone, based on the newly deliberated variables the second simulation suggested that Sierra Leone's inland pond aquaculture systems are some of the most vulnerable, as vulnerable as Sahel countries. However, the Sierra Leone participant suggested that as Sierra Leone is a coastal country it should not be more vulnerable than countries in the Sahel region. Discrepancies such as these highlighted the need to conduct specific assessments at the country level for more accurate conclusions.

Therefore, it was concluded that the technical outcomes of this exercise emphasized the further need to incorporate and utilize specific country data sets. This is important to make more conclusive recommendations that are better suited to guide policy formulation in relation to country NADPs and climate change NAPs. Regardless, the output of this exercise and its simulation is a step forward in demonstrating the common areas of concerns in regards to inland pond aquaculture developments, the polices that exists/lacking, and its vulnerability to climate change impacts in the Africa region.

3.3 Country level vulnerability assessments case examples

After the discussions and general agreement on the need to focus these models at the country level. WorldFish facilitators presented country examples of how this methodology was applied to build country level climate change resilience projects at the local and country local level. Two country examples (Vietnam and Malawi) were presented. For the presentation see Annex 3. These country case studies were presented to demonstrate to participants that should the analysis go forward, country level and district level diagnosis related to climate change impact and aquaculture developments have been conducted and are possible.

3.4 Implications of the policy review process

After the appraisal of the vulnerability assessment approaches, participants were invited to discuss the implications of the policy review process, identify gaps and provide their inputs on the potential areas to improve the policy component. The participants remained in their working groups to discuss the possible actions required. The outcomes are represented in Table 5.

Table 5 – suggestions on actions for improving aquaculture integration into climate change policies

Small Scale working group	
Private	**Public**
- Form pressure groups that lobby for climate change related actions - Form community by laws - Improve production techniques and technologies	- Mobilization and protection of ground water sources for aquaculture purposes - Assess water management infrastructure e.g. dam construction, reservoirs - Implement early warning systems

- Form farmer associations at the community level - Improve water management practices at the ground/farm level.	- Improve climate change and aquaculture related extension services - Improved land tenure systems for small-medium scale fish farmers - Spatial planning and zoning of aquaculture and other sectors (agriculture and livestock) - Form legislation and policies specific to small-scale aquaculture development and social protection - Provide subsidies to address limitations (access to quality feed and fingerlings, importation of products from competing markets) - Access to credit facilities
Commercial scale working group	
- Conduct data collection, site selection, and feasibilities studies more regularly - Rehabilitate aquaculture ponds in a climate smart manner - Improve climate smart extension training and stakeholder consultations - Devise climate smart policies, strategies, and plans - Investigate aquaculture systems that are less vulnerable to climate change impacts (e.g. recirculating systems and resilient culture species) - Examine and farm various species that can be cultured in various conditions - Develop aquaculture clusters, parks, zones, fish farmers associations and coops that can address impacts as a group - Investigate funding opportunities for climate smart related activities - Producers should advocate for climate change activities in the sector - Investigate the carbon/footprint/feed impacts of aquatic organisms and fish farming practices and value chain - Implement insurance schemes that can help larger commercial producers deal with disasters/shocks - Water harvesting and storage schemes to provide medium term adaptations - Concentrate on farm species with shorter grow out periods to reduce climate change impact exposure - Genetic improvement of culture species and strains - Development of market chains - Promote culture species tolerant to water stress/increased salinity - Access to credit schemes related to climate change adaptation - Access to tax rebates to increase profits to address regional fluctuations	

Despite aquaculture developments falling the responsibility of both the private and public sector, participants suggested that the pathways to implement this approach or a similar approach to this would be to go through vectors such as the Global Environment Facility (FAO-GEF) programme, for example, to conduct country specific vulnerability assessments. It would be for the impetus at the country level to then plan and carry out how to best do a direct country analysis in areas that 1) have the most potential for aquaculture development and 2) are most subject to climate change impacts.

3.5 Follow-up actions of country participants

The workshop requested the participants, in light of the learned outcomes, to declare what possible actions can be done to integrate climate change adaptation measures into both aquaculture development plans and national adaptation plans with the aim to accelerate country level actions to build a more resilient aquaculture sector in the SSA region. The actions declared are represented in table 6.

Table 6 – follow up actions for climate change adaptation and aquaculture development advocacy workshop participants

Country	Declared actions	Time Frame
Benin	1. Bring together farmers, associations to raise awareness about climate change and identify national climate change impacts/challenges 2. Meet fingerlings producers to identify the challenges faced in their farms related to climate change stressors 3. Bring together local extension and workers from associations, farmers for share results and suggest concrete actions to improve vulnerability in response to climate change impacts.	Start by November 2016
Democratic Republic of the Congo	Conduct workshop to officials in Katanga district 1. To adapt and implement strategy for development of aquaculture 2. Incorporate aquaculture in adaptation plan as impacted by climate change 3. Discuss with NAP focal point to Carry out potential impact and vulnerability study on aquaculture (as well as awareness raising) as the southern part of country considered as vulnerable	No specific time frame declared
Ethiopia	1. Communicate among farmer groups and bring awareness to practices and climate change impacts 2. Summarize and present the impact of climate change in aquaculture development to high level officials and policy makers in July meeting. Aim to add aquaculture in the climate change resilience agenda 3. Inform research communities to develop and implement climate smart aquaculture projects	1. Immediate 2. July 2016 3. Immediate
Ghana	2. Review aquaculture policies immediately to be mainstreamed into climate change adaptation. 3. Build capacity on climate change impacts to extension officers on climate change measures specific to aquaculture 4. Host consultation workshop with stakeholders for the public and private sector better to mitigate the effects of climate change on aquaculture (with funding from on going World Bank project)	3-6 months
Kenya	1. Disseminate knowledge and push for capacity building of extension agents with regards to aquaculture 2. Integrate aquaculture in food productions, improve	Starting immediately at the district level

	irrigation Promote integrated systems (fodder-aquaculture) 3. Formation of more producer organizations for multi-sectorial activities 4. Water harvesting policy to be funded by relevant institutions to assist water use in aquaculture and agriculture production	
Malawi	1. Implementation of NAP by 2017 and revision of national aquaculture strategy to ensure vulnerability assessment implementation 2. Improvement of fast-growing tilapia, harvest before drought strains to be investigated 3. Improve technology for catfish culture production systems with regards to water-stress factors.	1. Immediate 2. By end 2016 3. Open-ended
Mozambique	1. Capacity building in aquaculture and climate change impacts 2. Provide genetic varieties (qualitative and quantitative) in tilapia systems 3. Produce fish feed that locally sourced and less detrimental to environment	No specific time frame declared
Niger	1. Present the workshop findings to relevant ministries 2. Develop terms of reference to carry out a vulnerability assessment of the aquaculture sector and submit it for future development and funding 3. Lobbying for funding on climate change adaptation for aquaculture	By the end of 2016
Sierra Leone	1. Sensitization of aquaculture and climate change adaptation during current constitutional change and influence environmental concerns at the policy level. 2. Formalization & registration of farmer groups by December 2016. 3. Organize and include aquaculture issues and production statistics in national agriculture publications by December 2016.	1. Immediately 2. By Dec. 2016 3. By Dec. 2016
Uganda	1. Review the national aquaculture policy/plan/strategy to include climate change adaption. No specific timeline provided. 2. Capacity building for extension staff 3. Workshop to raise awareness on climate change impact on aquaculture where funds permit	No special budget in 2016, will try to insert in 2017-18 work plan
United Republic of Tanzania	1. Organize registration of farmer groups supported by previous technical cooperation programmes to be able to advocate for climate change adaption measures 2. Training on assessment on vulnerability of climate change for small scale farmers and extension agents 3. Ensure climate change issues are mainstreamed within the review of the NAP 4. Look for funding to conduct national vulnerability assessment specific for aquaculture	All by Dec 2016

Zimbabwe	1. Organize meeting with Ministry of Agriculture and Ministry of National Parks and Wildlife to develop an aquaculture strategy and integrate within NAP process 2. Conduct consultative workshop with a group of experts, focusing on community-rural development (last quarter, by November) 3. Submit small budget feasibility study on status of aquaculture and climate change vulnerability (end of June 2016)	1. July 2016 2. Nov 2016 3. June 2016

4. Closing

Participants closed the workshop by thanking for the opportunity to learn more in an area that is often overlooked and encouraged FAO and WorldFish to develop a more regular working group to share future activities and ideas related to climate change adaptations and aquaculture for the Africa region. Participants also highlighted the success of the workshop declaring for each participating country the areas for improvement in aquaculture's long-term sustainability and the need for more attention at the country level. Further, the importance of advocacy for aquaculture development was emphasized and its need to ensure climate change adaptation and aquaculture mainstreaming into national adaptation policies.

This workshop concluded with declarations that participants upon, their return to their countries carry out lobbying and advocacy activities for adaptions measures in the sub sector. FAO-RAF closed the workshop and acknowledged all relevant key persons, the donor and host country, Ethiopia in making this workshop take place and successful.

Annex 1 – Opening statement

Opening Remarks

Validation Workshop

Climate Proofing Aquaculture in sub-Saharan Africa: Review of Policy and Production Systems for Climate Change Resilience

Addis Ababa, Ethiopia: 9 – 10 June 2016

Distinguished guests,
Ladies and gentlemen,

1. In name of Mr Jose Graziano da Silva, the Director-General of FAO, I would like to welcome you all to this validation workshop which gathers aquaculture experts from across the region to discuss the vulnerabilities of aquaculture production systems to climate change across sub-Saharan Africa.

2. This workshop comes at an opportune time when all countries have agreed upon a historic Agreement in Paris at COP21 to tackle climate change at a global scale. Countries are currently in the process of ratifying their commitments made through their National Determined Contributions which put high emphasis on adaptation. At the same time countries are also engaged in the planning process to develop National Adaptation Plans to increase the capacity to cope with the impacts of climate change at medium-to long term and knowing the vulnerability of the different food systems form the basis.

3. In 2013, FAO conducted a review of the short-term National Adaptation Plans of Action and it was concluded that a clear gap existed with regards to climate change vulnerability assessment of the aquaculture systems across Africa to influence the adaptation and climate change policy processes. Countries across Africa are at different stages within this process, and looking at the important role the aquaculture sector plays in terms of livelihoods, health and nutrition and trade, it is crucial that the aquaculture sector plays its part while ensuring the development of a resilient and sustainable future in the light of climate change. A production increase six-fold from 55 690 tonnes in 2000 to 359 790 tonnes in 2010 was recorded and this trend is expected to increase. But

4. The Fifth Assessment Report of the IPCC indicated that four out of the eight key risks identified, have close relation to food security and it will be the poorest and most vulnerable that will be disproportionately affected by the impacts of climate change. Most small-scale fish farmers in developing countries are depending heavily on ecosystem services and natural feed and stocks to support their livelihoods. As such it is critical to improve our understanding of the vulnerability of the affected aquaculture systems and not only at the production level but also in terms of access, processing and utilization of the natural resources.

5. With support from Norway and in collaboration with WorldFish Center a desktop policy review was carried out to look at the current situation of selected countries across SSA in the context of preparedness of aquaculture planning in terms of climate change and vice versa. A preliminary indicator-based aquaculture-related vulnerability assessment was also undertaken to improve the understanding of the current knowledge and situation at the continental level to inform the decision-makers about the importance of resilience considerations in commercial and small-scale fish farming systems.

6. FAO and World Fish Center are seeking now your advice and expertise to have a critical look at the model used to determine the vulnerability of the inland aquaculture systems to climate change taken into consideration your own national specificities.

7. In closing, let me thank you all once again for your participation and your attention and I wish you good deliberations and discussion to set the stage for a climate-resilient aquaculture development in Africa.

Annex 2 – Workshop agenda

Validation Workshop
Climate Proofing Aquaculture in sub-Saharan Africa: Review of Policy and Production Systems for Climate Change Resilience
GCP/GLO/322/NOR
9th – 10th, June, 2016 FAO-SFE, Addis Ababa, Ethiopia

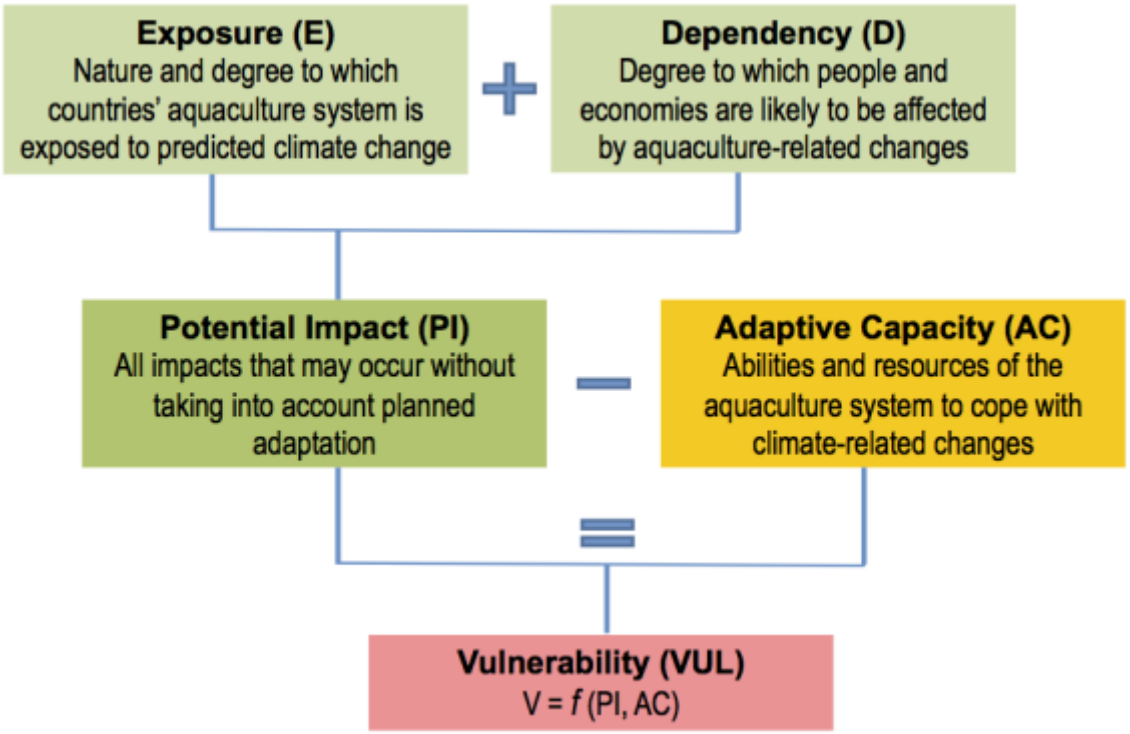
Agenda

Day 1:		
8:00	Registration	FAO
8:30	Opening remarks/overview of the project	FAO
8:45	Participant introduction	All participants
9:00	Country reporting - Profile of aquaculture - Types & production levels of aquaculture	Country representatives
10:30	Coffee break	
10:45	Likely impacts of CC on aquaculture	Malcolm Dickson (WorldFish)
11:15	Policy review of selected countries - Current situation - Gaps	Malcolm Dickson (WorldFish)
12:00	Lunch	
1:30	Vulnerability assessment - Country level comparison among SSA countries	Kam Suan Pheng, Teoh Shwu Jiau (WorldFish)
2:45	Coffee Break	
3:00	Factor weighting for: - Small-scale pond aquaculture - Commercial-scale pond aquaculture	Kam Suan Pheng, Teoh Shwu Jiau (WorldFish)
4:30	End of day 1	
Day 2:		
9:00	Present results of vulnerability assessment - Interpretation & review if necessary	Kam Suan Pheng, Teoh Shwu Jiau (WorldFish)
10:00	Coffee Break	
10:15	Implications on policy specific to SSA adaptations of aquaculture to climate change impacts	Malcolm Dickson (WorldFish)
11:30	Lunch	
1:00	Feasible actions that participants can undertake for their countries	Malcolm Dickson (WorldFish)
2:30	General discussion – way forward	
3:30	Coffee Break	
3:45	Closing remarks	
4:30	**End of workshop**	

Annex 3 – web links to workshop presentations

Presentation	URL Link
Climate Change Polices and sub-Saharan African Aquaculture	https://www.dropbox.com/s/pjicex4c1o17nlj/CC%20policies%20and%20SSA%20aquaculture.pdf?dl=0
Likely impacts of climate change on African aquaculture	https://www.dropbox.com/s/37vr73yi0ncycjl/Likely%20CC%20impacts%20on%20SSA%20aquaculture.pdf?dl=0
Indicator-based assessment of pond aquaculture-related vulnerability to climate change for sub-Saharan countries	https://www.dropbox.com/s/o994evcd6jw27sn/Vulnerability_Presentation.pdf?dl=0
Results on Vulnerability Assessment	https://www.dropbox.com/s/om6lcg9crdd6o8p/Vulnerability_Group_Results.pdf?dl=0
Decision support for water management for integrating aquaculture in small-scale irrigation systems: A case for the Chingale catchment in Malawi	https://www.dropbox.com/s/l84gsgeprm8ywhb/WF-2013-40.pdf?dl=0

Annex 4 – vulnerability model overview



Adapted from Allison(2005) & FAO (2013)

Annex 5 - Exposure indicators and variables

Indicator	Variable/Data	Unit	Measure of	Impact on Aquaculture	Data source
EXPOSURE					
Rainfall patterns	Variation in long-term annual rainfall (CV, 1960-2014)	percent	The change in intra-annual rainfall variability (relative to mean value)	Greater rainfall variability increases uncertainty of water supply for rainfed production systems, including fish ponds	HarvestChoice (2015)
	Long-term annual rainfall (mean, 1960-2014)	mm	The trend of change in annual rainfall amount (mean value)	Decreasing rainfall amounts reduces water availability for fish ponds	HarvestChoice(2015)
Sea level rise (SLR)	Impacted area due to SLR of 1m	km^2	The extent to which a country is subjected to flooding and salinity intrusion due to SLR	Flooding causes damage to aquaculture installations. Salinity intrusion may provide opportunities for brackish-water aquaculture	CRESIS (2010)
Desertification risk	Vulnerability to desertification considering soils, climate, land resource stresses and population density (2000)	Unitless	The severity of exposure to increasing desertification	Higher desertification risk reduces potential for aquaculture	Reich *et al.* (2001)
Drought risk	Drought hazard, taking account of annual rainfall and groundwater resources (1998-2000)	Unitless	The severity of exposure to drought conditions	Higher exposure hazard increase chances of facing water shortage for fish ponds	CIESIN (2005)
Water risk	The physical risks related to water quantity due to supply availability and variability from rain and groundwater sources	Unitless	The uncertainty of water supply due to seasonal and inter-annual fluctuations causing droughts and floods	Greater uncertainty of water supply reduces potential and productivity of aquaculture	WRI Aqueduct Water Risk (2015)
Climate risk	Index of weather-related loss events from 1992 to 2011	Unitless	The frequency of occurrence weather-related extreme events (e.g. storms, floods, heat waves); not restricted to coastal extreme events	Higher occurrence of extreme events constitutes threat of damage to aquaculture installations	GermanWatch Climate Risk Index (2013)

- *Flood risk: no data available*
- *Temperature rise: not considered crucial as direct impact on aquaculture species; drying effect taken into account by drought and desertification risks*

Annex 6 – Dependence indicators and variables

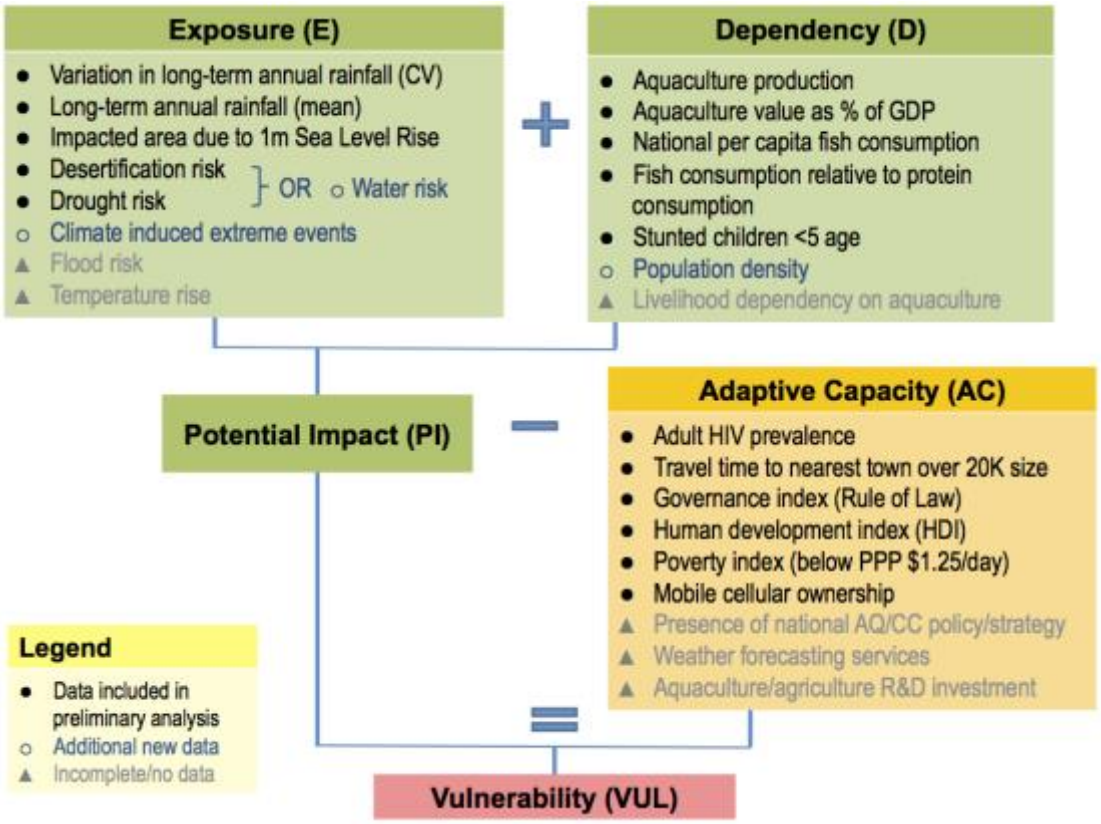
Indicator	Variable/Data	Unit	Measure of	Impact on Aquaculture	Data source
DEPENDENCY					
Aquaculture production	National production from fresh and brackish water aquaculture (2011)	Tonnes	Importance of aquaculture in terms of fish production at the national level	Higher production levels shows greater dependency on the aquaculture sector	FAO (2011)
Economic value of aquaculture	Aquaculture value relative to national GDP (2011)	Percent	The relative importance of aquaculture production value to the national economy	Higher share of aquaculture production to the GDP shows greater economic dependence on the sector	FAO and WorldBank (2011)
Protein food security	National per capita fish consumption (2011)	kg per capita per year	Importance of fish to meet food need and security	Higher fish consumption suggests increasing dependence on aquaculture production to offset decline in capture fisheries output	FAO (2011)
	Fish consumption relative to protein consumption (2011)	Percent	Importance of fish as protein supply in the diet		FAO (2011)
Child malnutrition	Children under-five who are stunted (moderate and severe) (2013)	Percent	Importance of increasing protein production to fulfill nutritional deficiency	Higher malnutrition suggests increasing importance of producing more fish to meet protein needs	UNICEF (2014)
Population/population density	Population density based on land area (2011)	People per km^2	Local demand for fish as source of animal protein	Higher population density suggests greater demand for fish	WorldBank (2013)
- *Livelihood dependency on aquaculture (e.g. % HH involved in aquaculture): no data available*					-

Annex 7 – Adaptive capacity indicators and variables

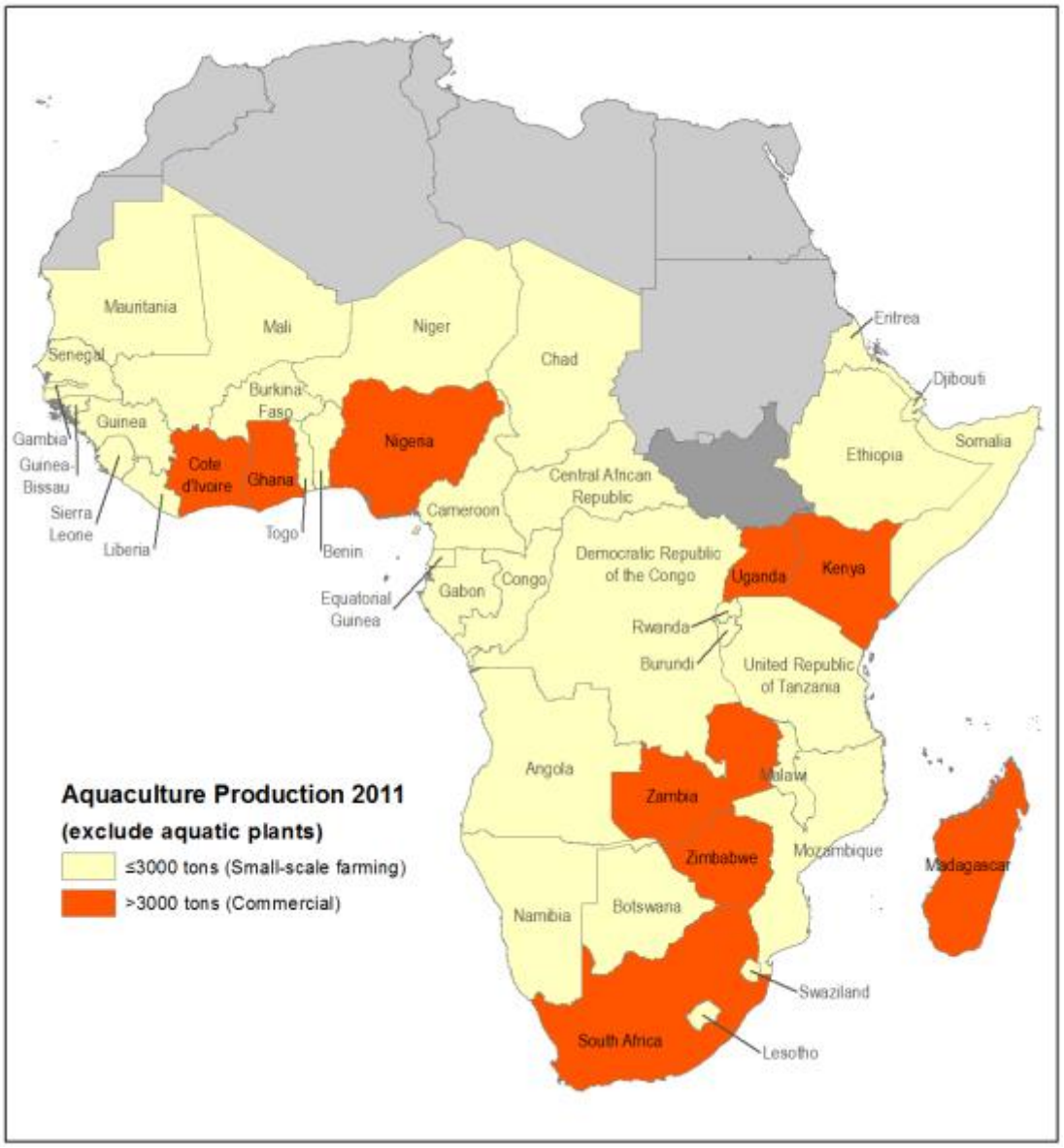
Indicator	Variable/Data	Unit	Measure of	Impact on Aquaculture	Data source
ADAPTIVE CAPCITY					
Health	Prevalence of HIV cases among adults (2011)	Percent	Health and employability status of the working population	Higher HIV prevalence implies lower capacity for gainful employment and labor productivity	UNDP (2011)
Transportation and accessibility	Mean travel time to nearest town over 20,000 in size (2000)	Hour	Accessibility to small towns in terms of markets	Better accessibility implies greater ease to get inputs, sell products or even seek alternative income	HarvestChoice (2015)
Governance	Governance index: Rule of Law (2011)	Unitless	The extent to which agents have confidence in and abide by the rules of society	Better rule of law eases access to land and water resources	Worldwide Governance Indicators (www.govindicators.org)
Human welfare	Human development index (HDI) (2013)	Unitless	Socio-economic strength in terms of longevity, education and gross income to cope with change	Higher HDI implies higher adaptive capacity	UNDP (2013)
Poverty	Poverty indices (below PPP $1.25/day) (2012)	Percent	Prevalence of poverty in terms of people living below the poverty line	Higher poverty incidence suggests less economic resources to cope with change	UNDP (2013)
Access to information	Mobile cellular ownership (2013)	Subscriptions per 100 people	Connectivity to sources of Information – markets, prices, Advisory services, etc.	Higher subscription levels suggests better access to information for enhancing farm productivity and increasing adaptability	WorldBank (2013)

- *Presence of policy/strategy: to link with Malcom's policy review*
- *Weather forecasting services: no data available*
- *Aquaculture/agriculture R&D investment: large data gaps, questionable quality*

Annex 8 – The overview of all indicators and variables for each vulnerability component

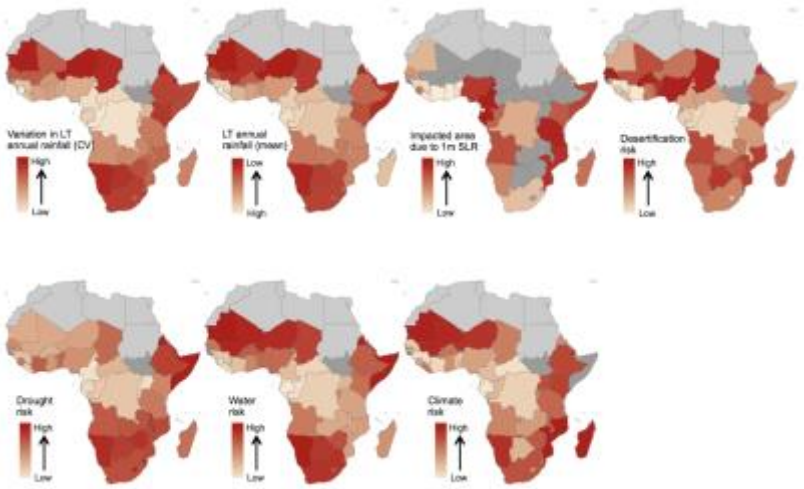


Annex 9 – Overview of African aquaculture systems

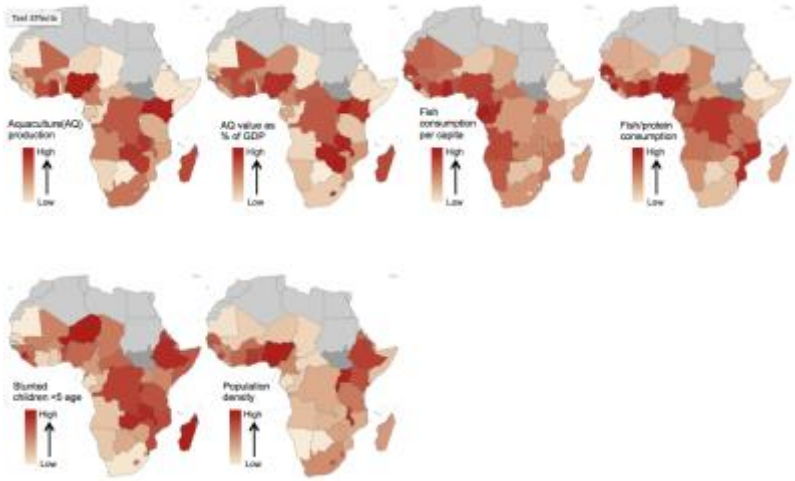


Annex 10 – Maps of exposure, dependence and adaptive capacity indicator variables

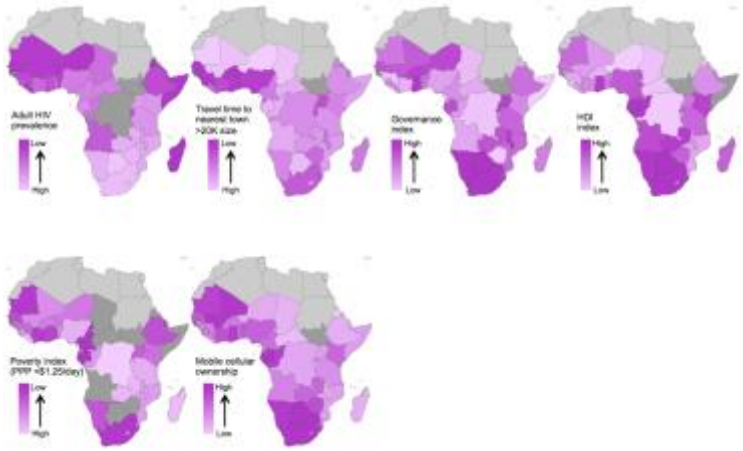
Exposure



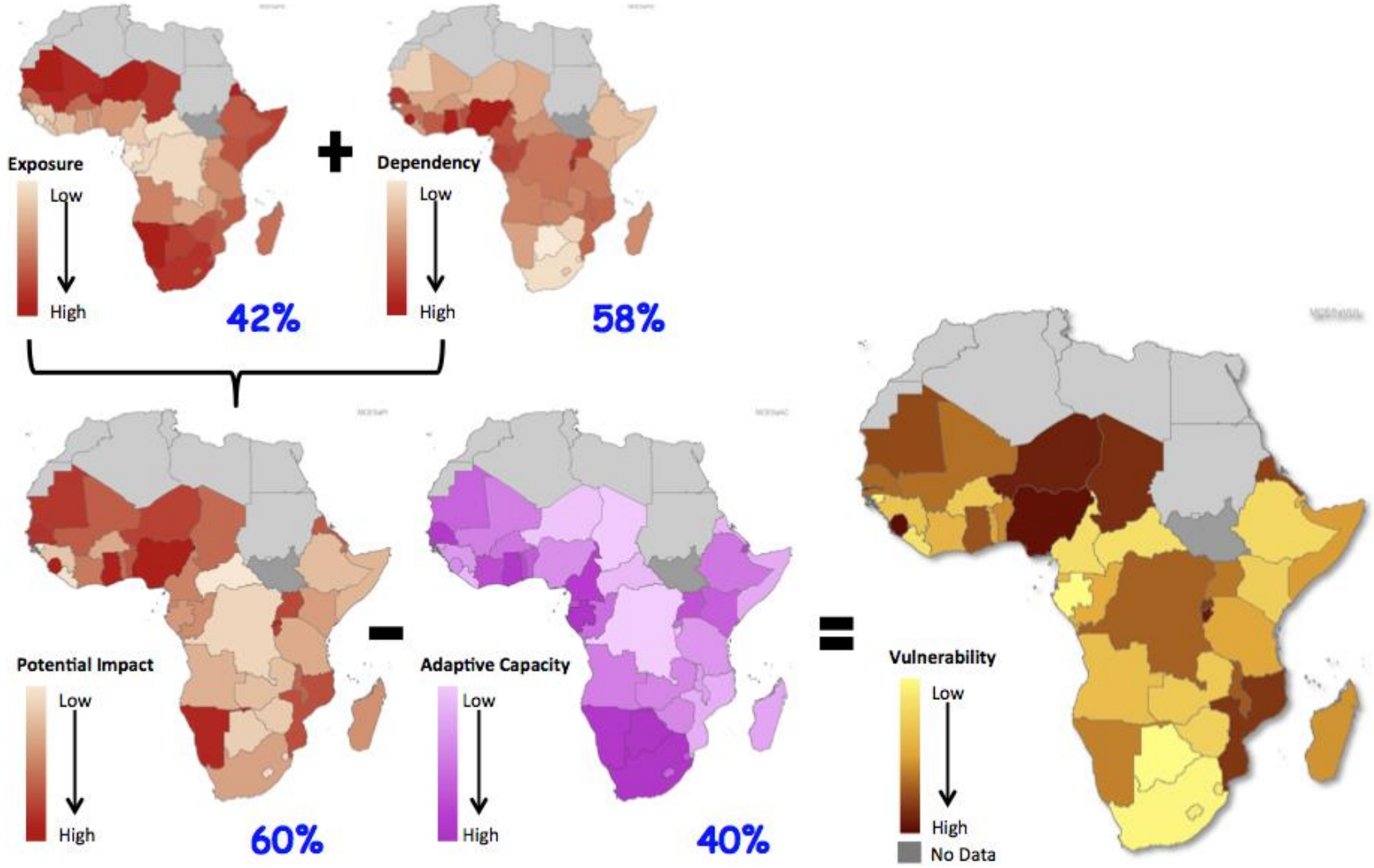
Dependence



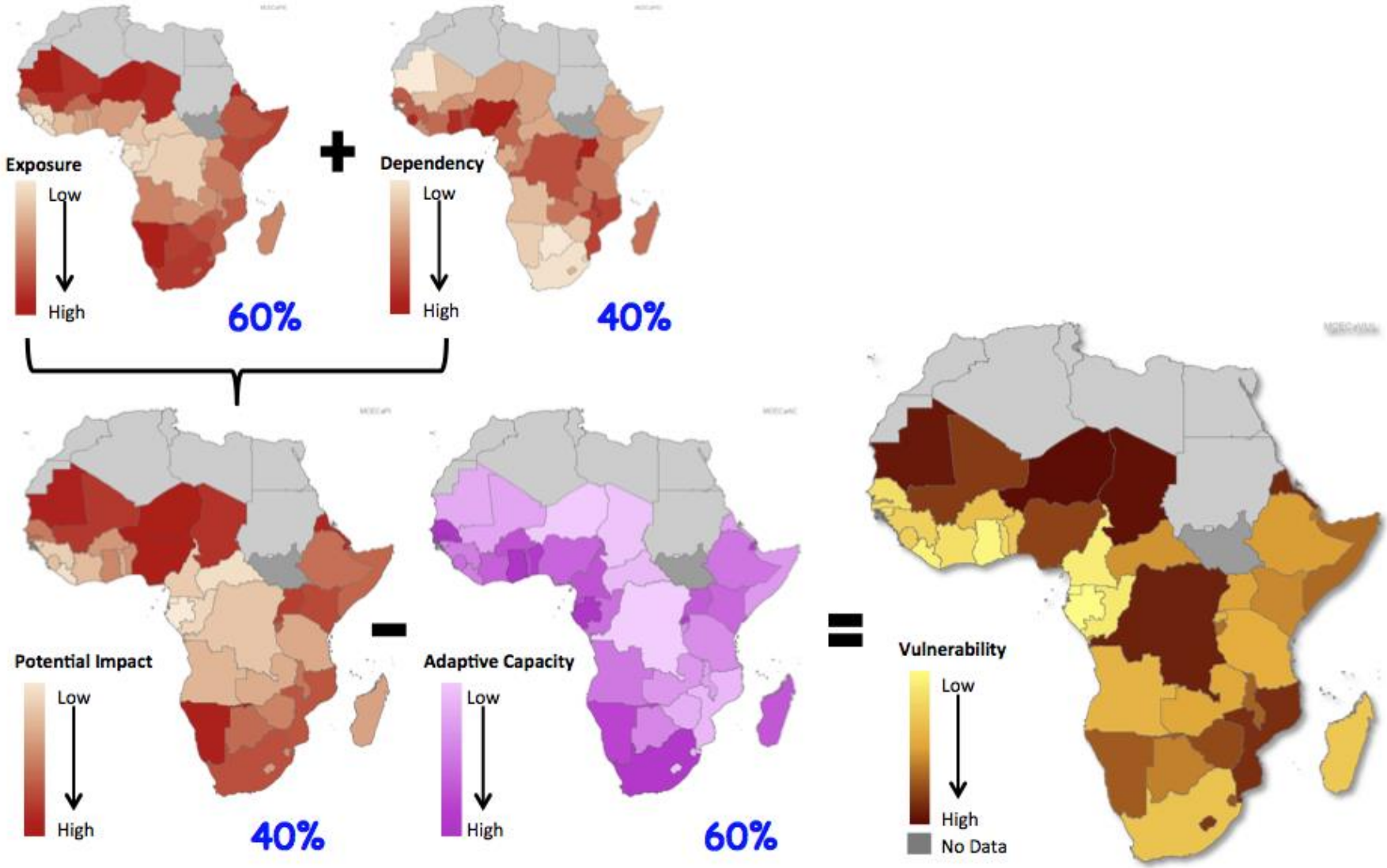
Adaptive capacity



Annex 11 – Post deliberation: vulnerability of small-scale inland pond aquaculture systems



Annex 12 - Post deliberation: vulnerability of commercial inland pond aquaculture systems



Annex 13 – Workshop participant list

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This document contains the Report of the Workshop on Climate Proofing Aquaculture in sub-Saharan Africa: Review of Policies and Production Systems for Climate Change Resilience held in Addis Ababa, Ethiopia, 9–10 June 2016. The Workshop analyzed Climate change risk impacts at the Africa region. WorldFish and FAO-RAF conducted a regional diagnostic that highlighted the region's current aquaculture status and climate change impact adaptation measures under two corresponding components: (1) *Vulnerability assessment:* through the incorporation of datasets (i.e. meteorological, aquaculture and socio-economic variables) a climate change vulnerability exercise was conducted using an indicator-based model. (2) *Policy review:* to further the diagnosis of African aquaculture and obtain a better understanding of where climate change adaptive policies exist in Africa, the project conducted a policy review related to climate change adaptation and aquaculture. This component aimed to establish what measures exists and do not exists, what policies re currently being implemented, and what policies require revisions across the sub-Saharan Africa region.

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