JOINT STATEMENT OF
MARIA LOURDES SAN DIEGO-MCGLONE, PhD Chemical Oceanography
LAURA DAVID, PhD Physical Oceanography
AND PORFIRIO ALIÑO, PhD Marine Chemical Ecology

We were invited by Ms. Veronica Cabe, a petitioner in the human rights and climate change case to act as resource persons for the petitioners to explain ocean acidification, sea level rise and the impacts of climate change on the marine environment in the first public hearing of the case on March 27-28 at the Commission on Human Rights in Quezon City, Philippines.

We agreed. Copies of our *Curriculum Vitae* are appended to this statement.

In our offices at the University of the Philippines Marine Science Institute, the legal representatives of the petitioners Attorneys Zelda Soriano and Hasminah Paudac explained to us Maria Lourdes San Diego-McGlone and Laura David on 8 March 2018 and Perry Aliño on 15 March 2018 our role and the purpose of our presentation. On our part, we described to Attorneys Soriano and Paudac the scope of our presentation.

Considering that the topic is uncommon, technical and scientific, we agreed to the legal representatives' concern that interviewing us and documenting our answers may not be easy and precise so we supplied to Attorneys Soriano and Paudac the abstract of our joint presentation to serve as our joint statement.

The abstract is as follows...

Excerpt from Climate Change Impacts on Food Security from Marine Resources
L. David, T. dela Cruz, R. Azanza, M.L. McGlone

The specific values differ for each of the IPCC5 RCPs (Representative Concentration Pathway Scenarios) but the CMIP5 models project that in the near-term climate change scenario (2016-2035) the Western Equatorial Pacific region shall experience significant increases in sea surface temperature (mean ocean surface change of 0.5-0.75°C). Global sea-level rise is projected at 20-90 cm per decade with the Western Equatorial Pacific region likely experiencing the higher of these global estimates. Ocean pH is globally projected to decrease 0.1 unit in the near-term. Slow persistent increase in ocean temperature have been associated to distribution limit consequences of marine flora or fauna (Gaston, 2000; Carricart-Ganivet, 2004; Somero, 2010; Tittensor et al., 2010).

Temperature sensitive species will likely adapt to warming waters by temporarily migrating to deeper waters or permanently migrating to higher latitudes where temperatures will still be conducive for typical functioning. For those that cannot migrate, the prediction is for negatively affected reproduction and recruitment failures (Donelson et al. 2010, Ljunggren et al., 2010; Pankhurst and Munday 2011).

Decline of locally available fish populations and eventual local extinction is likely. One consequence of elevated temperature is sea-level rise. For moderate rates of sea level rise enhanced vegetation growth is likely as the ecosystem strives to adapt. At faster rates of SLR vegetation however, mortality ensues as the substrate deepens beyond depths capable of supporting vegetation (Kirwan et al., 2010). Also, adults that are only salinity tolerant for short periods of time (typically located more shoreward) will suffer from prolonged exposure to seawater. Over the longer term, the impacts of sea-level rise on mangroves and mangrove associates need not necessarily be negative, provided shoreward migration is possible (Waycott et al, 2011). More intense sea level rise is likely to impact seagrass meadows. Higher sea-level expose more of the coast to erosion bring about increased nutrient and sedimentation. High nutrient input can be good for the seagrass as these meadows are known to be nutrient poor. However, the increased sedimentation can bury seagrass meadows or at the very least leave the water murky for extended periods of time. These will compromise seagrass productivity (Gacia, et al., 2005; Orth et al., 2006). In terms of fisheries this specifically impacts on seagrass related fisheries such as that of rabbit fish and prawns. It will also have a cascade effect on larger target fish since seagrass meadows provide food for these higher trophic levels.

Ocean acidification have also been observed to negatively affect the recruitment success of temperate species (Simpson et al., 2011; Munday et al., 2009) but may not necessarily be disadvantageous for tropical benthic-spawning marine fishes (Munday et al., 2009b). Coral reefs however,are highly susceptible to degradation from increases in ocean temperature (coral bleaching) and reduced calcification due to ocean acidification (Munday et al. 2008, Pratchett et al. 2011, Hughes et al. 2003, Hoegh-Guldberg et al., 2011). Loss of coral cover, typically result in the decline of smaller-bodied coral-associated fishes that are dependent on the structure of reef habitat for shelter (Graham et al. 2008). Only the small generalist species and rubbledwellers are expected to increase in abundance on degraded coral reefs (Bellwood et al. 2006; Ticzon et al., 2012). These species are generally not utilized as food fish.

There are also particular economically important species that require the presence of all three coastal habitats to be sustainable such as groupers. As habitat health is degraded due to climate change larger predators will also be affected (Sundblad, 2014). This can happen in two ways. Both pelagic and demersal predators also use the mangroves, seagrass, and corals as nursery ground. Hence, their population will also be compromised as the habitats get degraded. In addition, as the smaller habitat-affiliated fishes are compromised the predators may end up migrating to more bountiful cooler and deeper areas. This will tax small-scale fishers who have limited mobility.

An alternative food resource is mariculture which is a more controlled environment. But experience has shown that this is not climate-proof either. Anomalous warming of ocean water affects the oxygen content of the water and has historically resulted to massive fish kills within mariculture sites (David, et al., 2014). Increase in surface ocean temperature might also abet the formation of algal blooms. Algal blooms impact aquaculture either due to its toxic nature or by further reducing the oxygen content of the water. Ocean acidification on the other hand is also likely to compromise large-scale commercial shellfish culture.

Moreover, unregulated and mismanaged mariculture can result in eutrophication, anoxia and toxicity causing massive fish kills (San Diego-McGlone et al., 2008; David, et al., 2014) and actually exacerbate the climate story.

Our high biodiversity reduces the overall vulnerability since species having similar ecosystem functions allow for adaptation to slow changes. [1] There is need therefore to conserve and protect the different alluvial, estuarine and coastal habitats – especially those identified as spawning and nursery grounds.

Corollary to this, increase human utilization of the coastal zone, if mismanaged, can further exacerbate the vulnerability. [2] A comprehensive ridge-to-reef management must therefore be put into place to mitigate human activities that lead to increase input of nutrients and pollutants or alter the natural buffering capacity of these biodiverse habitats. [3] The opportunities to enhance our food security through mariculture should also be fully realized by exploring culture of other indigenous climate tolerant species without compromising the existing natural biodiversity. [4] In order to do these, careful site selection must be undertaken – taking into consideration local water renewal, the history & potential of an area for climate-related or bio-chemical stress (e.g. HABs), and potential impact of the mariculture area to surrounding habitat. Enhancement of the adaptive capacity of coastal communities therefore relies heavily on the LGUs through the Philippine local government code. Coastal LGUs need to be made to understand and appreciate their role in the transition towards a climate adapted archipelago. Their decisions will need to take into account social and economic, as well as, ecological concerns. [5] Hence, decision makers need to be provided assessments of valuation of coastal ecosystem services, as well as, adaptations costs and benefits. Further, there are still uncertainties on the magnitude of local future scenarios and consequently lack of quantitative predictions of local future coastal changes. [6] There is need to develop local predictive models based in multi-stressor observations and experiments in detailed levels of space and time. Finally, all these science-based data will then have to be communicated to decision-makers and institutions so that their role in the transition towards a climate adapted archipelago may be realized. [7] Therefore, there is a serious need to strengthen the science-to-policy communication.

Nothing further.

Maria Lourdes San Diego-McGlone, Ph.D
Date of signing:

Laura David, Ph.D
Date of signing:

Porfirio Aliño, Ph.D
Date of signing: