Policy Briefing Front Cover:

Coral Bleaching In The Great Barrier Reef: The Need For Local and Global Climate Change Governance.

Figure 1- Comparison of the Great Barrier Reef the left shows a healthy area (Bell, 1998), contrasted with the bleached area on the right (Grace, 2016 as cited in Hocevar, 2016)

Division of Global Sustainable Development, University of Warwick,

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Executive summary:

Coral bleaching is a pressing issue as sea temperatures rise. The global rise in temperature is due to the increasing amounts of greenhouse gases such as CO_2 in which absorbs short wave radiation leading to an increase in temperature. This could potentially cause the failure of ecosystems as they can no longer support themselves or the animals surrounding them. The Great Barrier Reef provides vital ecosystem functions as well as ecosystem services. However, despite the Great Barrier Reefs role it has been subject to many mass coral bleaching incidents due to climate change. Previous climate governance has tried to limit these impacts including the Kyoto Protocol, Paris Agreement, and the Emissions Reduction Fund. Yet, all prove unsuccessful as mass coral bleaching still occurs with the latest bleaching event in 2020. To effectively manage and limit the collapse of coral ecosystems governance is needed with joint action between the UNFCCC and local governments as well as increasing public awareness and capacity building to ensure the true cause and impacts of coral bleaching are understood. Furthermore, this can provide the opportunity for community-based management of coral reefs to ensure coral bleaching and the impacts of climate change are combatted on a local and global scale.

Foundational Science: Discussion and Analysis:

The Great Barrier Reef (GBR) consist of coral reefs, mangroves, and eelgrass meadows, which stretches across an area of more than 2,300 km along Australia's coast (Figure. 2) (Stoeckl et al., 2011, pp.113). These coral reefs are fundamental to the environment by providing critical ecosystem functions as well as ecosystem services as seen as degradation of coral is the main cause of biodiversity loss (Hoekstra, et al, 2004).

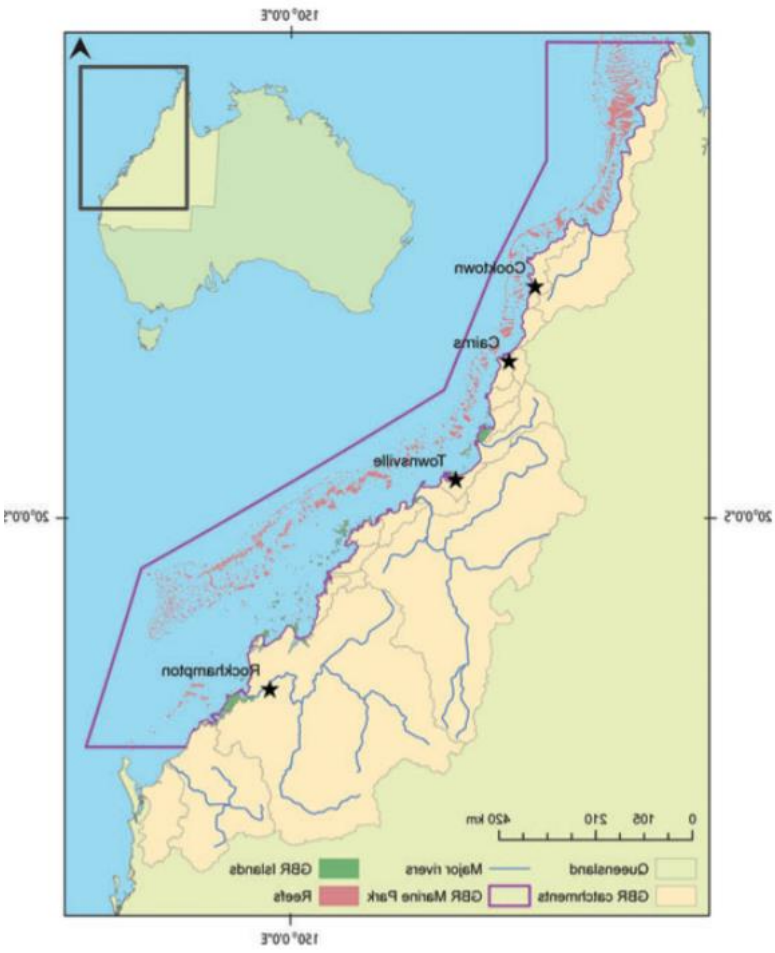

Figure 2- Map displaying the area of the GBR which experiences the coral bleaching (The GBR and environs, as cited in, Stoeckl, et al., 2011)

These fundamental ecosystem services can be outlined in figure 3 which represents the vital support the GBR gives to provisioning, regulating and cultural services (Stoeckl, et al., 2011). Displaying not only the environmental benefit of the GBR but also economic as sectors such as tourism, research, and recreation (Figure 3) rely on the GBR (Stoeckl, et al., 2011). Furthermore, the critical role the GBR provides to society can be outlined in the report published by Deloitte Access Economics in 2017 which estimated that the economic and social assets of the GBR were valued at AU$56 billion (Deloitte Access Economics, 2017, pp. 5-7).

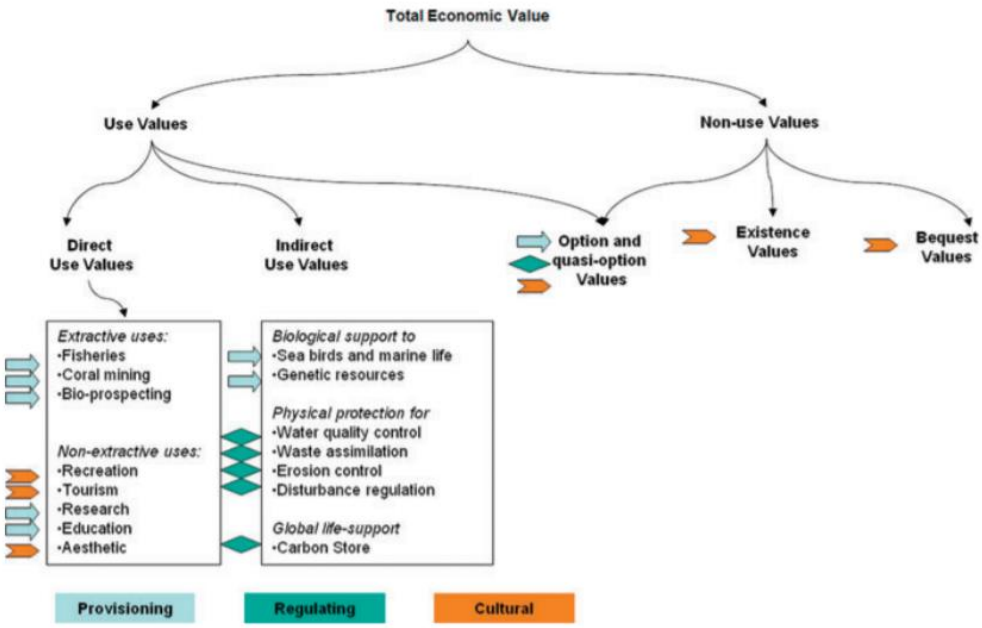

Figure 3- Diagram showing the total economic value through the uses of ecosystem services (MEA ecosystem services and the TEV framework, as cited in, Stoeckl, et al., 2011)

However, coral reefs are becoming increasingly vulnerable to climate change most notably in the GBR portrayed through the statistic that the northern area of the GBR lost nearly 50% of surface water corals due to the mass bleaching of 2016 (Hughes et al., 2017, pp.373). This is due to the rise in greenhouse gases such as the CO_2 increase, absorbing short-wave radiation from the sun causing global temperatures to rise thus, impacting oceans as 'tropical oceans are warming at 70% of the global average rate' (Lough, 2012, pp.2) and having a damaging effect of coral ecosystems (Wilkinson, 1998). This is through the process of coral bleaching as ocean temperatures rise it causes the coral to expel algae (Zooxanthellae) causing the loss of colour and the potential collapse of the ecosystem as it can no longer support itself (Reaser, et al, 2000). This effect is only enhanced due to the positive feedback system in which as global temperatures increase so does the potential to emit greenhouse gases indicating that within this relationship not only will emissions increase but so will global temperatures (Scheffer, et al., 2006). Thus, enhancing damages on the GBR and increasing coral bleaching. Therefore, it is evident that anthropogenic increase in ocean temperatures is having damaging effects on coral reefs (Hoegh-Guldberg, et al., 2007, IPCC, 2014) and climate governance is needed now.

Assessment of Existing Governance:

There have been several United Nation Frameworks put into place to try and combat the impacts of climate change an example of this is the Kyoto Protocol. The Kyoto Protocol was established in 1997 through the United Nations (Kyoto protocol to the UNFCCC, 1997). Within, the Kyoto Protocol there are many advantages and disadvantages as it set out to limit greenhouse gas emissions focusing on industrialised nations with the involvement of 192 parties (Kyoto Protocol, 2021) thus having a global collaboration to combat the effects of climate change.

However, the limits imposed on countries have not reduced the impact of climate change on coral bleaching as seen in 2016 and 2020 with mass coral bleaching (Lough, et al, 2018) which could be linked to the idea that only industrialised countries have to reduce the emissions of greenhouse gases when climate change is a global issue calling for a global response. Similarly, the Paris Agreement was set up in 2015 totalling 197 signatures to limit global warming by no more than two degrees Celsius (Adoption of the Paris Agreement, 2015). The benefits of the Paris agreement are a clear step in the right direction. For example, the Paris Agreement holds developed countries more responsible as Article Four outlines that varying countries have 'common but differentiated responsibilities and respective capability' (Adoption of the Paris Agreement, 2015, Article 4, Point 4). Therefore, the idea that the countries that emit more should have more responsibility in reducing emissions.

However, without it being legally binding it creates the issue of the free-rider problem as there is an incentive to do the minimum (Keohane, et al, 2016). This notion relates to the idea that although the Paris Agreement had a larger scope compared to the top-down approach of the Kyoto Protocol (Kyoto protocol to the UNFCCC, 1997). There was a limit to this scope due to the vagueness surrounding the Agreement. Therefore, without any binding obligation to implement plans countries continue to emit greenhouse gases leading to coral bleaching and the collapse of ecosystems.

Furthermore, when looking at a local approach to combat climate change and the impacts on the Great Barrier Reef this was aided by the adoption of the Emissions Reduction Fund (ERF) (Zihniah, 2021). Australia can be seen as one of the worst per capita greenhouse gas polluters (Australia to ditch climate targets bill after PM ousting Phys Organisation, as cited in Zihniah, 2021). The ERF was implemented in 2014 (CLIMATE POLICIES OF MAJOR AUSTRALIAN POLITICAL PARTIES, 2019) with the idea to incentivise local businesses to reduce emissions through technological advances or altering business practices in return for carbon credits which could potentially be sold to generate income (Zihniah, 2021). This was a good idea; however, the policy only really incentivises businesses and gives limited incentive for consumers (Hawkins, 2014). Within, this there is an evident theory that the ERF hinders Australia's efforts at achieving the targets set out by the Kyoto Protocol and the Paris agreement as many argue the ERF represented the influence companies have on policymakers as adopting the ERF was not environmentally beneficial (Zihniah, 2021).

Governance Recommendations:

Both national and international governance is needed to successfully combat the impact of climate change on our oceans.

1. **The promotion of public transport:**

Transport is one of the main sectors responsible for greenhouse gas emissions as around 24% of CO_2 emissions are due to fuel combustion (Khalili, et al, 2019,pp.1-3). Therefore, promoting public transport and the use of renewable fuels for public transport would reduce emissions. This promotion of public transport should first be localised to Australia due to private cars making up around 90% of city transport (Hossain, et al, 2014, pp.1). Which undoubtedly has severe impacts on the GBR. However, public transport should also be prioritised globally due to climate change being a global issue. This is best showcased in Sweden a comparison of in 2007 only 8% of buses ran on renewable fuel which increased to about 60% by 2014 causing bus emissions 'per vehicle-km decreased by 43%' in seven years (Xylia and Silveira, 2017, pp.402). This decrease in emissions would subsequently mean a limit to the amount of warming of the oceans and so coral bleaching becomes less common.

2. **Joint action between UNFCCC and local government:**

The collaboration between the UNFCC and local governments is essential to ensure that coral bleaching comes to an end. This should be developed through international policy to monitor the implementation of policies. Within this idea, the potential use of the existing framework and extending its reach through monitoring such implications. This could be done in a partnership with the International Coral Reef Initiative (ICRI), which aims to undo the damage of coral reefs as well as focusing on the management and condition of such ecosystems (Dight and Scherl, 1997). Similarly, the development of a legally binding protocol that has the same outline as the Paris Agreement could limit the free-rider problem and help hold countries accountable for emissions, damaging environmental actions and benefit ecosystems such as the coral reefs. An example of this implementation would be in the UK having the first climate change mitigation strategy which is legally binding setting out to reduce GHG emissions by 80% by 2050 (Climate Change Act, 2008).

3. **Increase public awareness and capacity building:**

There is a lack of trained workers that understand the cause and impacts of coral bleaching (Reaser, et al, 2000). Within this to have a local and global impact then the policy implementation of the provision of training as well as career opportunities within certain sectors such as ecology or marine biology would help build skills in the relevant fields to monitor the impacts of coral bleaching (Reaser, et al, 2000). Similarly, this is done through increasing public participation to achieve community-based management as seen in Figure 4 (Tran, et al, 2012). This involvement can be achieved through activities that raise awareness (Figure 4) as showcased within the Trao Reef Marine Reserve (Tran, et al, 2012). The outcome of this initiative portrayed that due to the community-based management the West section of Trao Reef experienced a rise of 18.3% in hard coral cover (Browyn, 2009 as cited in, Tran, et al, 2012, pp.27). This understanding of the relationship between humans and coral reefs is vital (Stoeckl, et al., 2011) and therefore with the combination of investment into training and career opportunities as well as public participation the understanding and management of coral reefs will increase. Ultimately, this would cause an increase in coral reef protection as seen in Trao Reef as well as aid the joint action between the UNFCCC and local government.

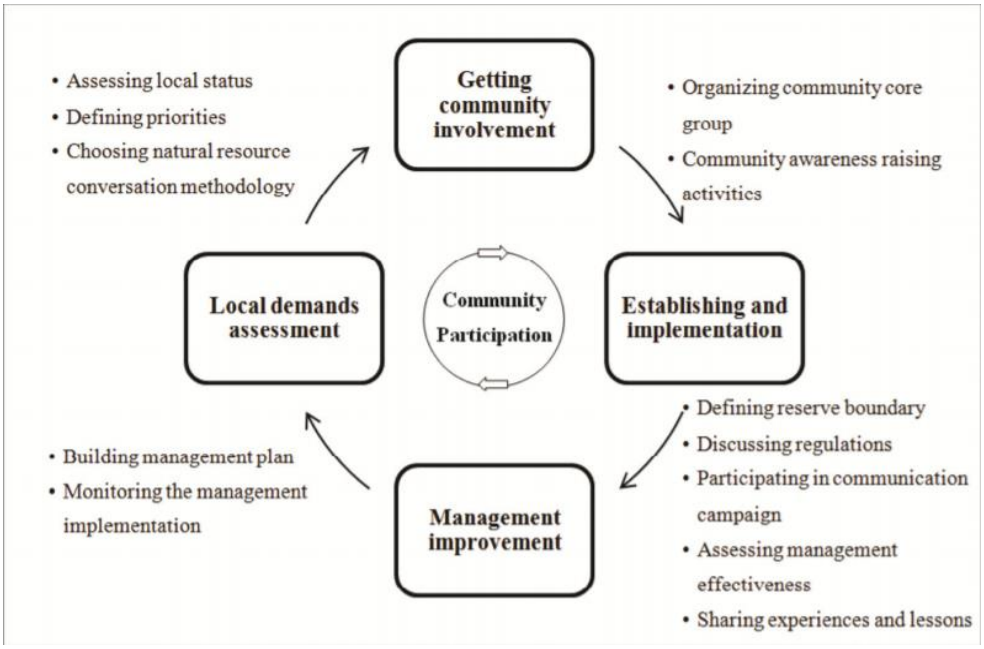

Figure 4- Diagram displaying the community-based management initiative (Adapted from MCD, 2008, as cited in, Tran, et al, 2012).

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