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A Review on the Great Barrier Reef: Australia

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Abstract: ***The Great Barrier Reef of Australia is considered as one among the Seven Natural Wonders of the World. It is the largest living structure on the planet, that's visible from space. It also holds the credit for the world's largest coral reef stretching 2,300 kilometers along the Queensland coastline and covering an area of 344,400 square-kilometers. Coral reefs are vitally important for a number of reasons. Not only are they incredibly diverse, providing ideal living environments for both endangered and non-endangered creatures, but they also act as protection against the damaging effects of waves and storms on coastlines. Like with any natural resource, the Great Barrier Reef faces some threats, including the degradation by a number of factors, including overfishing, pollution, and outbreaks of predatory species. The constant threats that loom over it means that the area has a considerable amount of conservation efforts in place. Lots of work is done each year to ensure that the delicate ecosystem of the reef is preserved for future generations; central to this effort is the Great Barrier Reef Marine Park, a protective designation established in 1975 meant to protect the reef and the species within it. This study provides an overview about the coral reefs and measures taken for their conservations using various technologies to bring about a sustainable environment.***
Keywords: ***Great Barrier Reef, Coral Reef, Sea Grass Meadows, Restoration, Conservation***

I. INTRODUCTION

A coral reef is an underwater ecosystem characterized by reef-building corals. Reefs are formed of colonies of coral polyps held together by calcium carbonate. Most coral reefs are built from stony corals, whose polyps cluster in groups. Coral reefs are vitally important for a number of reasons. Not only are they incredibly diverse, providing ideal living environments for both endangered and non-endangered creatures, but they also act as protection against the damaging effects of waves and storms on coastlines. In addition, they are the source of food for millions of creatures and provide jobs for numerous different people. Despite their importance; coral reefs are in rapid decline, over the past decade. Human impacts like fishing, coastal development, and pollution combines with the rising ocean temperature to push reefs increasingly into the low coral abundance, reduced biodiversity and degraded ecosystems services.

Though all those threats affecting the coral reefs need addressing, those associated with global ocean warming are the most serious. Within this context, reducing the impact of local threats has the potential to build much needed resilience for coral reefs as they face escalating threats from global climate change.

In this review, I took the case study of Australia's World-Heritage-listed, The Great Barrier Reef (GBR), one of the world's seven natural wonders; it is a prized World Heritage Area, the largest coral reef system and the biggest living structure on the planet. It sprawls over a jaw-dropping 344,400 square kilometers – an area so large that it can be seen from space. It contains extensive coral reefs and sea grass meadows that represent important tourism and cultural assets and supports commercial and recreational fisheries. Three of the "iconic" species and habitats of the GBR are the corals themselves, the sea grass meadows and the dugongs, which feed on the sea grass.

The GBR is worth a$ 15e20 billion/year to the Australian economy and provides approximately 64,000 full time jobs. Many of the species and ecosystems of the GBR are in poor condition and continue to decline.

GBR is the World's largest coral reef stretching 2,300 kilometers along the Queensland coastline and covering an area of 344,400 square-kilometers. It ranges in width from 100 km in the north to 200 km in the south and is generally bounded by the coast to the west and the Coral Sea to the east.

Apart from its wealth of coral reefs, the GBR also supports extensive high-value areas of sea grass and mangroves, and a range of iconic mega-fauna, including whales, dugongs, turtles, sharks, dolphins and large fish such as groupers. There are also valuable commercial and recreational fisheries. The GBR has been managed as a national Marine Park (GBRMP) since 1975 and was listed as a World Heritage Area (GBRWHA) in 1981. The World Heritage Listed area spans 348,000 km^2, which is slightly more than the 344,400 km^2 Great Barrier Reef Marine Park area because it also includes some 980 islands, internal waters, intertidal areas and other state waters.

II. AN ASSESSMENT OF GBR GOVERNANCE SYSTEMS: ANALYSIS AND RESULTS

A detailed legislative and literature review and targeted discussions are done with GBR policy-makers, managers and governance experts, to identify and describe some 15 governance domains and 40 sub domains of significance in the GBR. They focused on domains and sub domains substantively influencing GBR outcomes and targeted participants across Australian, Queensland and local governments and across industry, conservation and indigenous sectors.

The analysis covered 40 sub domains, organized across 15 domains and 3 themes: economic, social development, and environmental management.

A. High-Risk Sub Domains Requiring Transformational Change (Combined Rating 16e25)

First, the most significant one is the need for a successful global action to avoid greenhouse gas emissions in the Greenhouse Gas Emissions Management Sub domain. Secondly, there are various economic development sub domains that present significant risks. These include the Northern Australian Development, Major Development Project Assessment, and Regional Land Use Planning sub domains. Plans to increase agriculture in northern Australia, if not well managed, could over-ride gains made in reducing Reef water quality. Current weaknesses in the Major Projects Sub domain present a high risk to Reef health as well as creating uncertainty for economic investment. Problems in this sub domain arise from weaknesses in the Regional Land Use Planning Sub domain, which could better guide major project siting and avoid cumulative impacts. With pressure emerging from UNESCO, both the Australian and Queensland governments have made substantial efforts to establish new institutional frameworks for cohesive shared action in managing the future of the GBR (the LTSP Sub domain) and to significantly grow and deliver the resources required to achieve outcomes(through the Reef Trust Sub domain). While new, both of these sub domains face challenges becoming successfully established and stabilized, hence their high risk rating.

B. Medium-Risk Sub Domains Requiring Continued Effort (Combined Rating 11e15)

Though many of the sub domains are improving, reference back to the trial benchmark established, suggests some are in decline and need renewed reform. One example is the Regional NRM Planning and Delivery Sub domain, which has been affected by increasing centralism in government policy and program delivery in community based natural resource management.

C. Low Risk Sub Domains Requiring Continuous Improvement (Combined Rating 10 And Below)

Here the increased risks of failure within important sub domains can emerge rapidly with changes in leadership, oversight or legislation. Such short term problems can also, however, expose system-wide governance trends, including increasing ministerial discretion and limited legislative oversight.

D. As per the Researches Done, Which Reefs Are Best for Regenerating Coral Reef Ecosystems?

The well-connected coral reefs that have the best chance of surviving projected climate change along a pathway, as defined in the Paris Agreement, ensuring that the array of non-climate change related threats do not degrade or eliminate these reefs over this time period is of critical importance.

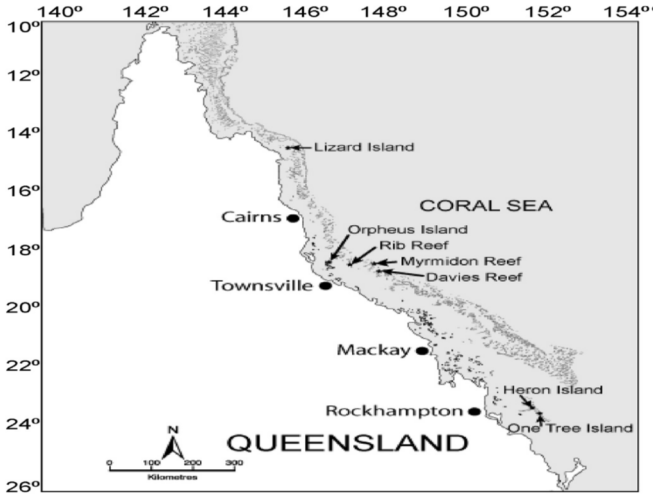

Fig.1. Map of the Great Barrier Reef off the coast of Queensland, Australia (www.imos.org.au).

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III. THREATS

Coral cover on the GBR has declined markedly in the period since the 1960s.Rapid ocean warming as a result of climate change poses a key risk for coral reefs. Coral reefs are likely to decline by 70–90% relative to their current abundance by mid-century. Although alarming, coral communities that survive will play a key role in the regeneration of reefs by mid-to-late century. In the case of coral reef conservation, uncertainty in projected long-term conservation outcomes is driven by variation in estimates of climate change impacts. Coral reefs are one of the most vulnerable ecosystems to ocean acidification. Laboratory experiments show that OA has the potential to affect the physiology, development, growth and behavior of key reef organisms.

It is seen that many of the key species and ecosystems, particularly corals, sea grasses and dugongs, inside the central and southern GBRWHA are in poor condition and on a generally declining trend. In 2015-2016, the GBR suffered the worst mass bleaching event on record, in which 93% of the 911 surveyed reefs experienced bleaching. Threats include increased sediment runoff, resulting in increased coastal turbidity affecting sea grass and corals, increased nutrient runoff, and adverse effects on corals associated with climate change, including coral bleaching, diseases and ocean acidification. In addition, calcification rates have declined across the central GBR as a result of thermal stress and some ocean acidification on mid- and outer-shelf reefs, but on inner-shelf reefs terrestrial runoff also play a part. There are many causes of the decline of coral cover, often reef-specific, including: terrestrial runoff of fine sediment causing more turbid conditions on the inner shelf and reducing light availability for coral growth ,nutrient runoff from soil erosion and fertilizer loss causing crown-of thorns starfish outbreaks, excess algal growth, enhanced sensitivity to coral bleaching and coral diseases; coral bleaching and mortality associated with climate change and increasing incidence of cyclones, which appears to have occurred over the last decade and is predicted to continue under climate change .Rainfall extremes and more frequent, larger river discharge events with elevated pollutant loads are also predicted to cause further severe impacts on GBR ecosystems. Ecosystem Service Policy and Delivery is significant as the surrounding ecosystem services is so poorly developed that resourcing available to improve reef water quality will not be adequate to improve ecosystem outcomes.

IV. CONSERVATION

Actions might include reducing coastal pollution by encouraging sustainable farming practices, rebuilding fisheries through regulating access and implementing harvest controls, establishing protected areas, and diversifying reef economies with supplemental livelihoods like, ecotourism, low-impact aquaculture, etc. Long-term conservation solutions require the integration of the interests of governments, local communities, businesses and non-governmental organizations, and other stakeholders to strengthen the protection of these valuable areas, especially under the remaining climate stress before climate stabilization is achieved. Though often highly localized, many threats to coral reefs are unfortunate: coastal and upland deforestation, untreated sewage and other point and non-point source pollution (i.e., agriculture), overharvesting, destructive fishing, and poorly planned coastal development. While individual reefs need customized and locally appropriate conservation plans and management, the commonality of threats suggests continued opportunities for sharing experiences and technologies between BCUs and other regions that face similar challenges. The ongoing conservation of reefs also requires an adaptive approach to policy development and management that explicitly sets out to identify and resolve knowledge gaps in our understanding of coral reefs, the mechanisms by which stressors such as climate change impact corals, and linkages between social and ecological systems. Most analyses indicate that these conditions will remove coral reefs for a very long time, affecting hundreds of millions of people, and hence arguing for urgent action to secure greater greenhouse gas emission reductions through the Paris Climate Agreement and other national and sub-national actions. Prioritizing sites constitute a global strategy or policy in itself. However, it can increase global awareness, political commitment and inform strategic and innovative investment into the conservation of the world's coral reefs. Without effective action on climate change the future is clear: our earth will no longer be graced with one of the world's most spectacular and important ecosystems. With urgent action, however, we have the opportunity to preserve coral reefs in a state where there is good chance that they will regenerate once again in a more stable ocean and climate.

The most important delivery subdomains that we consider need to be operating within a much stronger policy context include the:

1) Property Planning and Management Subdomain;
2) Floodplain, River and Drainage Management Subdomain;
3) Regional Land Use Planning Subdomain;
4) Ports Planning Subdomain;
5) Reef Regulation Subdomain;
6) Traditional Sea Country Management Subdomain; and
7) The Regional NRM Planning and Delivery Subdomain.

Reef Plan 2003 (Queensland Department of the Premier and Cabinet, 2003) aimed to halt and reverse the decline in water quality entering the Reef within 10 years, and focused on diffuse pollution from agriculture. To achieve its aim, Reef Pan 2003 stated the following objectives:

(i) Reduce the load of pollutants from diffuse sources in the water entering the Reef, and (ii) Rehabilitate and conserve areas of the Reef catchment that have a role in removing water-borne pollutants. Reef Plan 2003 outlines a set of activities to be carried out by multiple designated participants that would lead to an actual plan of on-ground activities.

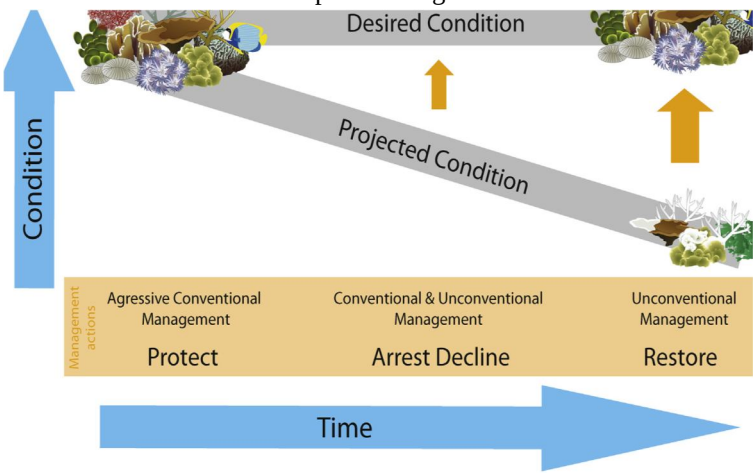

Fig. 2.Theoretical framework for managing the Great Barrier Reef (GBR) for ocean acidification in both space and time.

V. CONCLUSION

The Great Barrier Reef contains extensive coral reefs and sea grass meadows that represent important tourism and cultural assets and support commercial and recreational fisheries. In 2011, the United Nations Educational, Scientific and Cultural Organization (UNESCO) expressed concern over the decline of the outstanding universal value of the GBRWHA, because of the rapid industrialization of the Queensland coastline for port, urban and industrial development, and the recent proposals for expanded development of ports for export of unprecedented amounts of fossil fuels. As a result of these concerns, in 2012, UNESCO explored placing the GBR on the “World Heritage in Danger” list.

We argue for a global, long-term strategy for protecting coral reefs that are both least vulnerable to climate change, and which are well positioned to facilitate the regeneration of many coral reefs later this century. Restoration of coral reefs may make sense at some scales of intervention; we argue that the future for coral reefs depends mainly on the success of these approaches being used together with large scale conservation initiatives. To ensure that coral reefs persist beyond midcentury, strengthened conservation policies, innovative and expanded financing and increased on-the-ground capacity will all be required. However, much of the damage to coral, sea grass and dugong populations up to now has-been driven by water quality issues and not climate change. This damage includes crown of thorns starfish predation on coral being enhanced by nutrient runoff, reduced coral growth because of the reduction in light caused by sediment and nutrient runoff, damage to sea grass via reduced light associated with sediment and nutrient runoff and dugong mortality associated with loss of sea grass. Hence, the identification of climate change as the key threat to the GBR does not preclude efforts to manage water quality as a worthwhile objective to provide the GBR with resilience against climate change.

Sustainable conservation requires that the full set of interactions between people, ecosystems, and economic systems be taken into account. The development of emerging technologies and methodologies may provide important new opportunities for conservation. But many of these new technologies also come with significant risks, and hence it is essential that our scientific understanding of reef ecosystems be sufficient so that we avoid adverse outcomes that exacerbate rather than improve coral reef conservation outcomes. Substantially, long-term investment in research, as well as conservation and policy development, will be required to meet these questions and significant challenges. The ultimate goal of the prioritization and strategy proposed here is to ensure that coral reefs continue to provide livelihoods, food security, and other key services for future generations, despite the expectation that these benefits may be greatly diminished in many places over the next few decades. In a rapidly changing climate, conservation planning requires a long-term perspective that accounts for projected changes in environmental conditions, which is a perspective that has

sometimes been absent from previous planning exercises. Managers need the kinds of information we highlight here to sustain reef function into the future, and to deepen our understanding of long-term, ecosystem-level impacts of OA.

The Great Barrier Reef 2050 Long Term Sustainability Plan should have provided this focus and vision but failed to do so. The recommendations for the way forward as per the researchers are to:

1) Refocus management to the Greater GBR e that is; include management of Torres Strait, Hervey Bay and the GBR Catchments priorities along with the Great Barrier Reef World Heritage Area.

2) Strengthen management in the areas of the Greater GBR with ecosystems in relatively good condition, with Torres Strait Northern Cape York and Hervey Bay being the systems with highest current integrity.

3) Investigate methods of cross-boundary management to achieve simultaneous cost-effective terrestrial, freshwater and marine ecosystem protection in the Greater GBR.

4) Develop a detailed, comprehensive, costed water quality management plan for the Greater GBR.

5) Use the Great Barrier Reef Marine Park Act and the Environment Protection and Biodiversity Conservation Act to regulate catchment activities that lead to damage to the Greater GBR, in conjunction with the relevant Queensland legislation.

6) Fund catchment and coastal management to the required level to largely solve the pollution issues for the Greater GBR by 2025,to provide resilience for the system in the face of accelerating climate change impacts.

7) Continue enforcement of the zoning plan.

8) Australia to show commitment to protecting the Greater GBR through greenhouse gas emissions control, of a scale to be relevant to protecting the GBR, by 2025.

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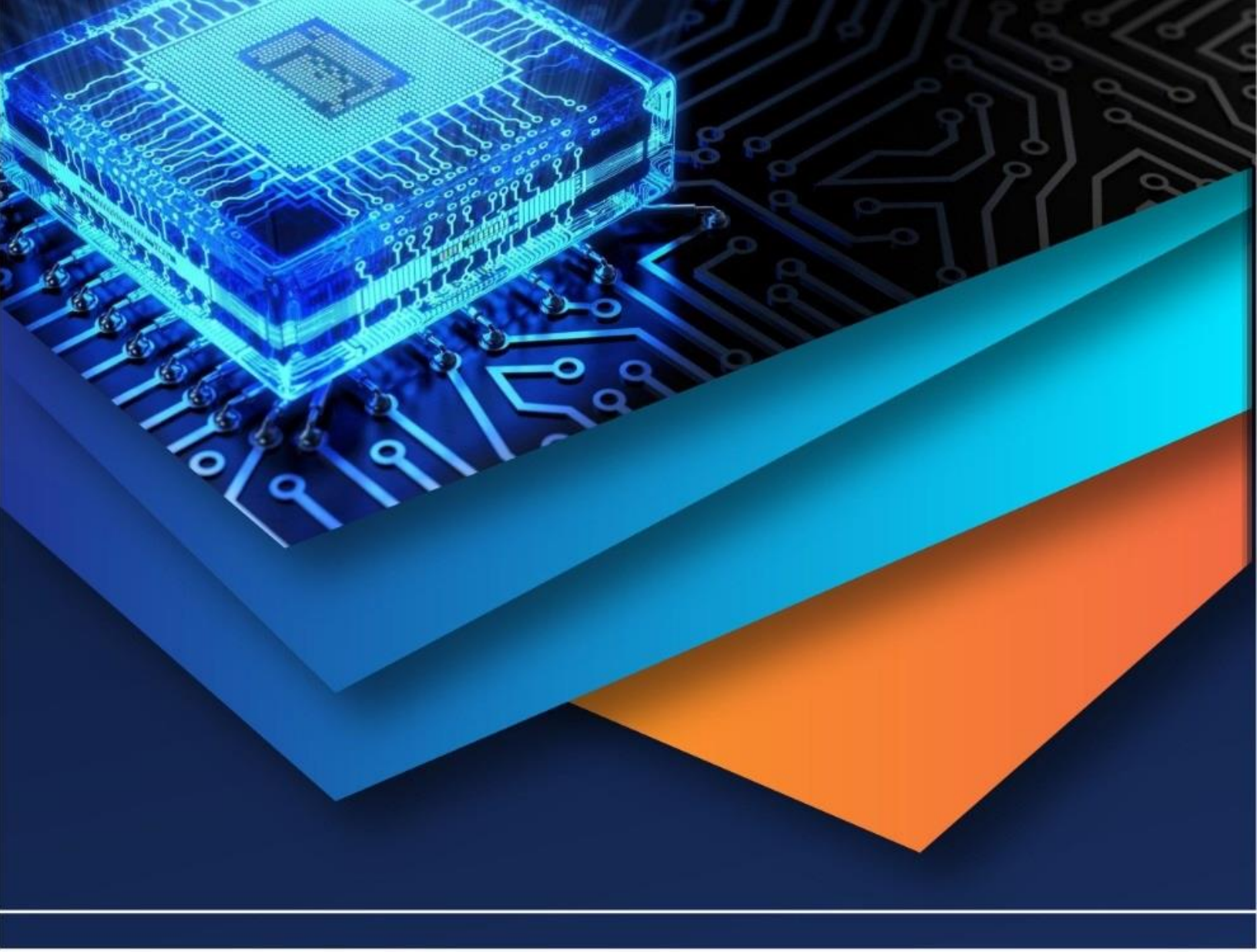

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