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Systematic Review on the Drivers of Coral Bleaching in India

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A.2. Abstract: Most of the papers on coral bleaching dealt with some basic knowledges which summarises as corals are **stressed by changes in conditions** such as temperature, light, or nutrients, they expel the symbiotic algae living in their tissues, causing them to turn **completely white is called Coral bleaching**. Depending on extent of bleaching, this may be categorised as healthy coral, stressed coral, bleached coral etc. Coral and algae depend on each other to survive. Corals have a symbiotic relationship with microscopic algae called zooxanthellae that live in their tissues. These algae are the coral's primary food source and give them their colour Stressed Coral: If stressed, algae leaves the coral. When, the symbiotic relationship becomes stressed due to increased ocean temperature or pollution, the algae leave the coral's tissue. Bleached Coral: Coral is left bleached and vulnerable. Without the algae, the coral loses its major source of food, turns white or very pale, and is more susceptible to disease. Warmer water temperatures can result in coral bleaching. When water is too warm, corals will expel the algae (zooxanthellae) living in their tissues causing the coral to turn completely white. This is called coral bleaching. When a coral bleaches, it is not dead. Corals can survive a bleaching event, but they are under more stress and are subject to mortality. A cold water temperature causes a coral bleaching event that resulted in coral death.

There are several causes of coral bleaching, depending on the location. In this project we have to search the papers where the causes of coral bleaching in that particular location. The extent of bleaching may be concluded on the water Quality index of other global factors. Depending on the nature of finding coral reef in geographical location researchers can conclude the causes of bleaching and vice versa. Depending on the nature of finding coral reef in a oceanic location they can conclude the causes of bleaching and vice versa. Nature of water quality, temperature, fish content etc. of the oceanic water etc. may be also predicted as primary findings without secondary testing. The research work has been carried out at least 10 to 15 arbitrarily chosen oceanic coastal areas in India where coral reefs are generally found in the most of the research papers.

A.3.Key words: Systematic Review, Mendeley, coral reefs, bleaching causes, Indian Regions, bleaching extent, etc.

B. Introduction:

In this systematic review process I have to search on the topic of coral reef within India and bleaching process in various searching engine to get the available best papers or book on it, then I have modified it the above title. Here the following process has been described in the term of Searching results. I have taken total 56 papers from different searching engines.

(1)1st Screening: From Scopus-Elesweiser searching using key words as "coral bleaching and India, searching date 02/11/2022, total findings was 25500 for at any time, since 2022 total findings minimizes as 2040, where only for review item is 206,for custom range 2000 to 2022 journal papers shortens to 1940.
(2) 2nd Screening: Coral Bleaching and India searching key from Elsevier.com results 52710, changing key words "coral bleaching" results only 150 available papers, whereas coral bleaching+ India finds results 866 available papers, changing key words: causes+coral bleaching+ India results 4273 available papers. Where only journal article 64 which is open access.
(3).3rd Screening: Changing date 03/11/2022 time 11.35A.M using key words" coral bleaching and India" from Elseviser, all results as 52,719 where Web page: 173, Books: 48,941, Journals: 2894, connect: 711, , Where only open access journal : 2803.
(4).4th Screening: .Changing key words as in the same Elesviser in the same date " Causes of Coral bleaching all results : 5003, where Web Page: 1267, Books: 3677, Journals: 54 where only open access journals: 53, and currently published journal: 51,
(5).5th Screening: Changing the key words in the Elesviser in the same date "coral bleaching India", all results 6044where web page 1745, Books: 4213, Journals 64, connect:2, where current 57/59, open access journal 61.
(6).6th Screening: Where key words causes of coral bleaching in Mendeley, in the same date 792 results most relevant 792 most recent and most cited, year wise 2022 (13), 2021(46), 2020(40),
(7).7TH Screening: Changing key words Coral Reefs in the Mendeley in the same date most cited data come year wise : 2021-3, 2020-2, 2019-6, 2018-1, 2017-1, 2016-1, 2015-1, 2014-5, 2013-2, 2012-4.
(8) 8th Screening: .Searching Key words- Coral bleaching India 99 results in the Mendeley, in the same date results 2022-1, 2021-9, 2020-9, 2019-7, 2018-70, 2018-70, 2017-5, 2016=5, 2015-1. 2014-5, 2013-9.

In this systematic review process the total idea of coral reef bleaching is cleared in Indian point of view. What need to do further to prevent coral from bleaching, what is the cause of bleaching, how coral could be increased or sustained, what are there importance could be solved. Paper wise analysis able to tell us which papers deals the particular coral related theory and problems, information etc. What is the new findings and new research areas in this particular coral related topics could be highlighted for further research and publication.

C. Objectives

The objective was to understand the trend of research in coral reef bleaching in recent times and determine the gap area. Following the above process and the literature review, systematic review give the following basic ideas and clear the objectives of needs for systematic review on the topic of coral reefs and bleaching process in India.(49) to (56).

Systematic review of the above topic will explain and able to understand the following points from 1 to 17 for any coral related research work.

1.What is coral bleaching?

When the Reef's waters stay too hot for too long, the coral becomes stressed and expel the colourful marine algae living inside their tissues, called zooxanthellae. Zooxanthellae provide the coral with food and energy from the sun (due to a process called photosynthesis), allowing them to grow and reproduce.

When corals get stressed, from things such as heat or pollution, they react by expelling this algae, leaving a white skeleton behind. This is known as 'coral bleaching'. Some corals can feed themselves, but without the zooxanthellae, most corals starve. A healthy Reef can recover from coral bleaching, but it needs time and the right conditions. Coral reefs take around a decade to fully recover.

2. Causes of Coral Bleaching:

Although some are more common than others, coral bleaching can have a number of causes.

a. Temperature.

b. Solar Irradiance. ...

c. Subaerial Exposure. ...

d. Sedimentation.

e. Fresh Water Dilution. ...

f. Inorganic Nutrients. ...

g. Xenobiotics.

h. Epizootics.

i. Greenhouse gas emissions are the main cause of ocean acidification and the **increases in sea temperature** that cause coral bleaching.

3. What is killing coral reefs?

Coral reefs face many threats from local sources, including: Physical damage or destruction from coastal development, dredging, quarrying, destructive fishing practices and gear, boat anchors and groundings, and recreational misuse (touching or removing corals)(14,40).

"Major Causes of coral bleaching or absence of coral reefs at Digha and other coastal zones of India" The Great Barrier Reef is immense, beautiful, diverse, and vibrant. The Reef supports thousands of unique marine animals and plants and our way of life.

Climate change is the biggest threat to the Reef, and is making marine heat waves hotter, longer and more frequent. Marine heat waves cause coral bleaching.

One of the many impacts of climate change is global warming, or global heating.

Other impacts for our ocean include an increase in intensity of cyclones, ocean acidification, and extreme weather events.

Coral reefs are not just beautiful, brightly coloured backgrounds for serene snorkelling experiences — they are vital to life on earth. At least a quarter of the world's marine life needs coral reefs for some part of their life cycle.

Despite their beauty and importance coral reefs around the world are disappearing fast. Water pollution, overfishing and coastal development are taking their toll on coral reefs at the local level, while carbon pollution threatens reefs worldwide and remains their biggest threat.

Record-breaking marine heat waves are causing mass coral bleaching on the Great Barrier Reef and coral reefs globally. Since 2016 the Great Barrier Reef has suffered four mass bleaching events. In March 2022 91% of the Reef was impacted by bleaching, and it was the first time the Reef bleached during a Digha weather event, which typically creates cooler, cloudier conditions

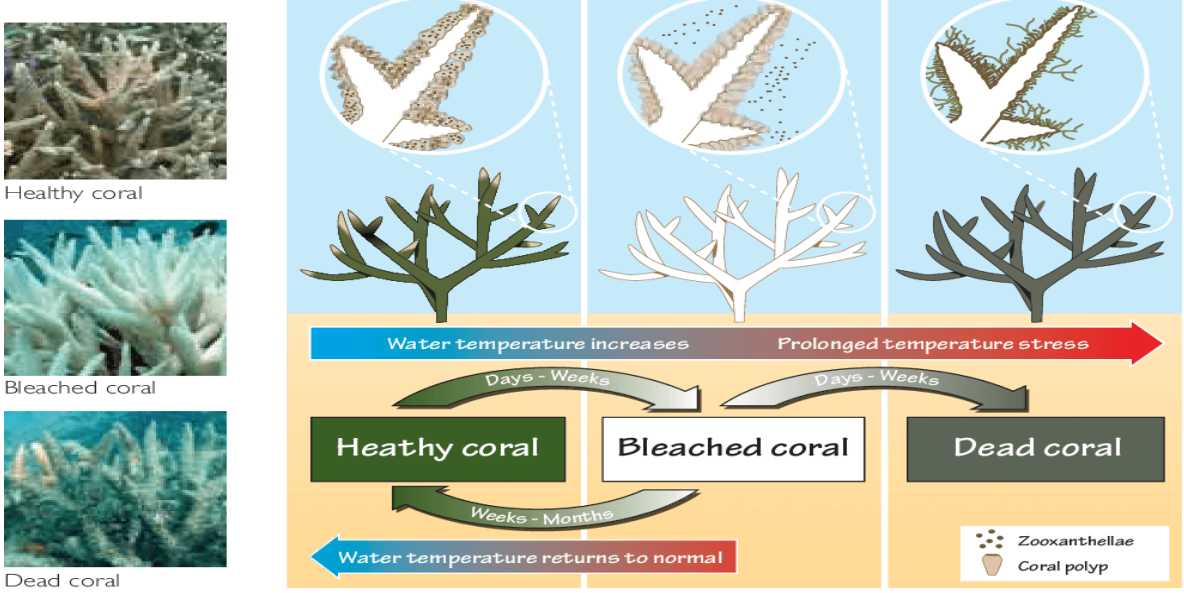

Image-1: Stages in mass coral bleaching.

4. Can coral recover from bleaching?

In some instances corals can recover from bleaching. **If conditions return to normal, and stay that way, corals can regain their algae, return to their bright colours and survive.** However prolonged warmer temperatures and other stressors, like poor water quality, can leave the living coral in a weakened state. It can struggle to regrow, reproduce and resist disease – so is very vulnerable to coral diseases and mortality.

It can take decades for coral reefs to fully recover from a bleaching event, so it is vital that these events do not occur frequently. If we continue burning fossil fuels at our current rate then severe bleaching events are likely to hit reefs annually by the middle of the century. This would be devastating for coral reefs as they would have no chance to recover.

We need to urgently reduce our carbon pollution and limit the global temperature increase to 1.5 degrees, or the world's reefs will face a bleak future.

5. What is resilience?

What it is and why it's critical for the future of coral reefs and the communities that depend on them.

Image-2, coral resilience.

We all know it’s important, and something that our children need to thrive, but what *is* resilience?

For people, resilience can be the ability to survive, adapt and recover from the stresses or adversities we face in our lives. An object is resilient if it can return to its original form after being bent, squashed or stretched.

For the world’s coral reefs and the ecosystems and people that depend on them, resilience is the ability to survive, adapt and recover from the stresses and shocks they experience as a result of climate change and other local threats. The system may not bounce back to exactly how it was before, but it will continue functioning in a similar way. It may even adapt and transform in a way that will help it better manage future shocks.

Image-3 CORAL REEF.

6. Why is resilience so important?

Coral reefs are critically important to the survival of the planet. Not only do they support 25% of all marine life, but nearly one billion people across the globe—in more than 100 countries—depend on reefs for food, wellbeing and livelihoods.

Reefs protect vulnerable coastlines from erosion and storms, contributing an estimated $10 trillion in ecosystem services. And thousands of First Nations groups hold deep cultural connections to reefs – with traditions and knowledge spanning tens of thousands of years.

Coral reefs are at risk on a global scale, with an estimated 75% of all coral reefs under threat from the combination of local stresses and a changing climate.

Building the resilience of reefs is essential to giving them, and the ecosystems and communities that rely on them, the best chance to prepare for and recover from disturbances, adapt to changes and plan for an uncertain future.

Rising water temperatures are a good example of these changes. On the Great Barrier Reef alone, higher temperatures have caused three mass bleaching events in just five years. If a resilient reef bleaches, it has the ability to recover and continue functioning in a similar way to before by providing habitat and food for other living creatures.

On the other hand, a coral reef that’s lacking resilience is less likely to recover from a bleaching event and could die out.

Image-4: coral resilience importance of protection.

7. What does a resilient reef and community look like?

Resilient reefs and their communities have the ability to survive, adapt and recover from the stresses and shocks they experience. This may be driven by many factors. A resilient coral reef has high levels of diversity which creates what's known as "functional redundancy". This is important because it allows ecosystems to survive even if some species are lost. For example, in a resilient reef there are many different types of animals playing a similar role. Parrot fish, surgeon fish and damsel fish all play an important role as herbivores, eating algae which can grow over and smother coral. Functional redundancy ensures that even if one of these species is lost there will be others playing that role in the system. But it's not just about diversity and redundancy. There are many other attributes of a resilient coral reef which can be found on TNC's Reef Resilience Network. Resilient communities are similar to resilient reefs – they have strong social networks and a diversity of people, knowledge and functions. Resilient communities also govern in an adaptive, nimble and flexible way which enables them to adapt and recover from shocks and stressors such as climate disasters, pandemics or an economic crisis. For example, in a resilient community there are diverse livelihood options that make it easier to thrive when a shock threatens one source of income. This is especially important for communities that depend on reefs, where a shock can end up putting increased pressure on the reef as communities return to livelihoods such as commercial fishing to make ends meet.

8. How are we building the resilience of coral reefs and the people that depend on them?

Through the Resilient Reefs Initiative, we're working with reef communities in four World Heritage listed sites to build the resilience of their reefs and communities. We do this in several ways. First, we fund new leadership in local reef management authorities—building local capacity for resilience-based management. These local leaders facilitate resilience planning, bringing together the reef management authority, community, Traditional Owners and scientists to develop a strategic plan outlining a range of actions to address their key threats. We fund the design and implementation of those actions, ensuring they benefit the reef and the community, helping both to become more resilient to future shocks.

9. What is driving marine heatwaves?

The mining and burning of fossil fuels releases carbon pollution into the air, which is warming our oceans and causing more frequent and intense marine heatwaves. The ocean absorbs excess heat and this creates above average sea surface temperatures. Since 1900 the ocean's temperature has warmed by 1°C. This may seem insignificant, however corals are very sensitive to temperature changes. Corals start to get stressed if temperatures increase by 1°C or more.

10. Why are marine heatwaves bad for the Reef?

Marine heat waves are dangerous for coral reefs because the hotter than average ocean temperatures stress corals and can lead to mass coral bleaching events. Marine heatwaves can last weeks, months or even years. If ocean temperatures remain high for eight weeks or longer, the coral cannot recover and begin to die.

Image-5,6. before and after photo of coral bleaching on Lizard Island, Great Barrier Reef, Queensland. Photo credit: The Ocean Agency.

11.What is the scientific outlook?

Scientists tell us that once we hit 1.5C of warming coral reefs will struggle to survive. If we don't keep 1.5C of global warming within reach this decade, the harsh reality is we will see more mass bleaching events and the rapid decline of our global icon.

In just seven years, our Reef has suffered four severe mass coral bleaching events, faster and more severe than scientists predicted. If we don't act to halt this pollution, we risk the future of our precious Reef.

12. We can solve the coral bleaching crisis – if we choose to

We have the solutions. With real leadership we can stop carbon pollution and allow our coral reefs to recover and rebuild. But to do this, **we must quit dirty coal, and transition to renewable energy today.** If we take climate leadership then our coral reefs, and the thousands of species that rely on them (which includes us), can rebuild and thrive for generations to come.

We must commit to:

- 100% renewables by 2030,
- Commit to an emissions reduction target of 75% by 2030,
- Commit to Net Zero by 2035,
- Commit to immediately ending the public funding and subsidies of coal, oil and gas,
- Commit to no further approval of fossil fuel infrastructure; and no new thermal coal, oil or gas projects.

13. How is our Great Barrier Reef affected?

Carbon pollution is causing unprecedented damage to our Great Barrier Reef. In recent years, our Reef has suffered severe mass coral bleaching, faster and more severe than scientists predicted.

If we don't act to halt this pollution, we risk the future of our precious Reef.

2022 – For the fourth time since 2016, our Reef has been hit with a devastating mass coral bleaching event, and the first in a Digha year, which is usually characterised by cooler, cloudier conditions. On the other side of the Digha continent, also showed signs of bleaching.

14. How coral bleaching is prevented?

Every Day Recycle and dispose of trash properly. Marine debris can be harmful to coral reefs. ...

1. Minimize use of fertilizers. ...
2. Use environmentally-friendly modes of transportation. ...
3. Reduce storm water runoff. ...
4. Save energy at home and at work. ...
5. Be conscious when buying aquarium fish. ...
6. Spread the word!

Warmer waters can trigger a coral bleaching where the coral turns white as it expels the symbiotic food-producing algae living in its tissues. Prolonged bleaching events often cause corals to die from starvation, but **they can recover if they reclaim their food source within a few weeks**. "We found that the time needed for coral reefs to recover from bleaching is at least **9-12 years** - if there is no new disturbance in the meantime, such as a cyclone or re-bleaching," he said. Dr Wolanski said the conditions that promoted recovery in different species of coral varied across the species. The higher and longer the temperature, the worse it gets. Ocean heatwaves cause stress for corals. Even a rise of just one degree Celsius for only **four weeks** can trigger bleaching in a coral. If ocean temperatures stay high for eight weeks or longer, the coral cannot recover and begins to die. **A 70-90 per cent decrease in live coral on reefs by 2050** may occur without drastic action to limit global warming to 1.5°C. Even with urgent reductions to greenhouse gas emissions, global ocean temperatures could still take decades to stabilize. When corals are stressed, they expel the zooxanthellae that live inside their tissues. Without the algae to provide colour, corals appear transparent and reveal their white skeletons. This is called coral bleaching. **Bleached corals are not dead, but are more at risk of starvation and disease**. Warmer water temperatures can result in coral bleaching. When water is too warm, **corals will**

expel the algae (zooxanthellae) living in their tissues causing the coral to turn completely white. This is called coral bleaching.

Without healthy reefs, "**you lose what is essentially a moving, undersea sea wall**," said Pendleton, who estimated that about 62 million people live less than 33 feet above sea level and less than two miles from a coral reef. "The waves just come into shore full force. That can cause loss of life. If coral reefs disappeared, **essential food, shelter and spawning grounds for fish and other marine organisms would cease to exist, and biodiversity would greatly suffer as a consequence**. Marine food-webs would be altered, and many economically important species would disappear.

Look at the color and shape. **Old dead corals will be broken down, and lack a healthy color**, and are sometimes covered in algae. Corals that have been bleached from rising ocean temperatures turn white when the symbiotic alga leaves the coral.

Healthy coral comes in shades of **olive green, brown, tan and pale yellow**. In a healthy coral colony no parts are affected by disease or bleaching.

The bleaching event in 2017 reached further south from Digha. A further estimated 20% of corals died. To compound this, a category four cyclone, with wind speeds up to 263 km/h that violently ravaged the Whitsundays region – decimating coral reefs in its path.

The combined impact of the two severe bleaching events, Cyclone Debbie and current severe outbreaks of coral-eating Crown of Thorns starfish since early 2016 has significantly impacted our Great Barrier Reef.

Coral reefs not found in the region from West Bengal to Andhra Pradesh but are found in Tamil Nadu and on the east coast of India?

Solution: **For corals to colonies, low siltation, low fresh water inflows by rivers , high salinity and optimal temperature are essential** . These conditions are not met in regions from West Bengal to Andhra Pradesh but are found in Tamil Nadu and on the East coast of India.

15. Coral Reef Carbonate Chemistry Variability at Different Functional Scale:

There is a growing recognition for the need to understand how seawater carbonate chemistry over coral reef environments will change in a high-CO_2 world to better assess the impacts of ocean acidification on these valuable ecosystems. Coral reefs modify overlying water column chemistry through biogeochemical processes such as net community organic carbon production (NCP) and calcification (NCC). However, the relative importance and influence of these processes on seawater carbonate chemistry vary across multiple

functional scales (defined here as space, time, and benthic community composition), and have not been fully constrained. Here, we use Bermuda as a case study to assess (1) spatiotemporal variability in physical and chemical parameters along a depth gradient at a rim reef location, (2) the spatial variability of total alkalinity (TA) and dissolved inorganic carbon (DIC) over distinct benthic habitats to infer NCC:NCP ratios [< several km^2; rim reef vs. seagrass and calcium carbonate ($CaCO_3$) sediments] on diel timescales, and (3) compare how TA-DIC relationships and NCC:NCP vary as we expand functional scales from local habitats to the entire reef platform (10's of km^2) on seasonal to inter annual timescales. Our results demonstrate that TA-DIC relationships were strongly driven by local benthic metabolism and community composition over diel cycles. However, as the spatial scale expanded to the reef platform, the TA-DIC relationship reflected processes that were integrated over larger spatiotemporal scales, with effects of NCC becoming increasingly more important over NCP. This study demonstrates the importance of considering drivers across multiple functional scales to constrain carbonate chemistry variability over coral reefs.

16. What is a coral reef made of?

A coral reef is made of thin layers of ***calcium carbonate***

Image-7: Coral polyps.

Coral polyps form a living mat over a calcium carbonate skeleton. Stony corals (or scleractinians) are the corals primarily responsible for laying the foundations of, and building up, reef structures. Massive reef structures are formed when each individual stony coral organism—or polyp—secretes a skeleton of calcium carbonate.

Most stony corals have very small polyps, averaging one to three millimetres (0.04 to 0.12 inches) in diameter, but entire colonies can grow very large and weigh several tons. These colonies consist of millions of polyps that grow on top of the limestone remains of former colonies, eventually forming massive reefs.

In general, massive corals tend to grow slowly, increasing in size from 0.5 to two centimetres (0.2 to 0.8 inches) per year. However, under favourable conditions (lots of light, consistent temperature, moderate wave action), some species can grow as much as 4.5 centimetres (1.8 inches) per year.

Climate change (7) and ocean acidification are both a result of increasing anthropogenic CO_2 in the Earth's atmosphere. These two global-scale stressors will impact coral reefs in differing ways, but the interaction of the two over the 21st century are expected to threaten the persistence of coral reef ecosystems

Imagr-8:An Example of Coral Tissue Sampling.

Reef-building corals comprise multipartite symbioses between the cnidarian animal hosts and their associated microbial populations of eukaryotic, prokaryotic, and viral microorganisms forming a coral microbiome, together known as a holobiont. The health of the entire coral holobiont of reefs is being negatively impacted by an increasing variety of environmental and anthropogenic stressors that can cause shifts in the community structure patterns of coral microbiomes. Many corals around the world are being increasingly stressed and degraded or even killed by changing conditions that can lead to greater exposure to pathogens and incidence of bleaching and/or coral disease. The biodiversity of coral reef communities, including biodiversity of the coral microbiomes, can be an important factor involved in coral health and resilience. The establishment of ongoing Genomic Observatories to characterize corals and their microbiomes can be a useful diagnostic and assessment tool to judge the relative health conditions of reefs and assess the effectiveness of management strategies intended to protect them. Such coral genomic observatories can be an extremely useful addition to larger Marine Biodiversity Observing Networks (MBONs) that serve to holistically characterize ecosystem health, status, and trends.

17. Physical Oceanography (7)

Ocean currents and waves are like the life blood of coral reef ecosystems: they bring nutrients, prey, and new recruits, and may carry away or dilute particulates and harmful chemical compounds. Currents are the medium connecting reefs with estuaries, channels, mangrove forests and seagrass beds inshore, and with the deeper oceans that invariably lie offshore of the reef. Together with direct air-sea exchanges of heat, water, gases, momentum, and nutrients at the sea surface, ocean currents largely control the physical and chemical environment of coral reefs. Yet while significant advances have occurred, especially over the past 30 years, our scientific knowledge of the physical oceanography of coral reefs is far from complete.

The complex physical interplay between wind, waves, water density (which is determined largely by sea temperature, but also by salinity), pressure, solar radiation, and the hard boundaries of the ocean make physical oceanography a challenging subject. For coastal oceanography, especially near reefs, the complexity of and rapid gradients in sea-floor bottom topography heighten these challenges. Furthermore, wind and waves in such environments may cause relatively violent water motions and heavy sediment loads, and the ongoing ecology of the reef itself may cause significant biofouling. Thus, the gathering of useful physical data to enhance our understanding of coral reefs becomes a very significant operational and practical challenge in it.

D. Methodology:

As per the above available primary data of the research I have searched Coral reefs in the Google search Engine, here I have found more than 99000 papers. To minimize and to get best result I have changed the searched words into various option, where Coral bleaching and India was my best try with Google Scholar and Scopus, which give me best results and was shorten the work into nearly 99 papers in that searching date. Out of 99 papers I have made a link of nearly 56 papers in the Mendely Reference Management Software where a prior registration with my email account was done. After that I have made an Excel Sheet where searching tools, paper name, Authors, Abstracts, volume, issue date, Key words, URL, Conclusion etc. data were tabulated. Apart from that Departmental library/central Library books also help me in this review work. But systematic review is done with the help of the mentioned software. It is true the available data are different in different date and time. To get best result it should be carried out in the same date with searching tools and words etc. Some basic steps has been followed to carry out this systematic review of this available primary data on the taken topic and basic ideas.

First in this systematic review process I have searched on the topic of (a) coral reef zone in India. (b) the cause of bleaching process there. With the help of various searching engine I have found the best available

papers or book on it. Here the following process has been described in the term of systematic Review. Total no of shorted papers in the excel sheet is 56.

Different Searching results: (14)

(1)From Scopus-Elsewiser searching using key words as "coral bleaching and India, searching date 02/11/2022, total findings was 25500 for at any time, since 2022 total findings minimizes as 2040, where only for review item is 206,for custom range 2000 to 2022 journal papers shortens to 1940.

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(5).Changing the key words in the Elsevier in the same date "coral bleaching India", all results 6044where web page 1745, Books: 4213, Journals 64, connect:2, where current 57/59, open access journal 61.

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(7).Changing key words Coral Reefs in the Mendeley in the same date most cited data come year wise: 2021-3, 2020-2, 2019-6, 2018-1, 2017-1, 2016-1, 2015-1, 2014-5, 2013-2, 2012-4.

(8).Searching Key words- Coral bleaching India 99 results in the Mendeley, in the same date results 2022-1, 2021-9, 2020-9, 2019-7, 2018-70, 2018-70, 2017-5, 2016=5, 2015-1. 2014-5, 2013-9.

Systematic Review is done in the Excel Sheet, where the 56 papers data are inputted in tabular form. Some of papers which has been carried out there are representing in tabular form in word format in below. The data in tabular form helps us to get best results on research work progress on the above topic. Various graphical representation or charts could be drawn. And from Results conclusion could be drawn.

In the Excel sheet we input the following data in table-1

Item Type-SL. No	
Publication Year	
Search Engine	
Journal or Book name.	
Search Strings	
Author Name	
Title	
Publication Title	
Issue	
Volume	
Abstract	
Key Words	
Methodology	
Sample Size	
STUDY Area	
Result	
Conclusion	
Paper Publication	
Citation	

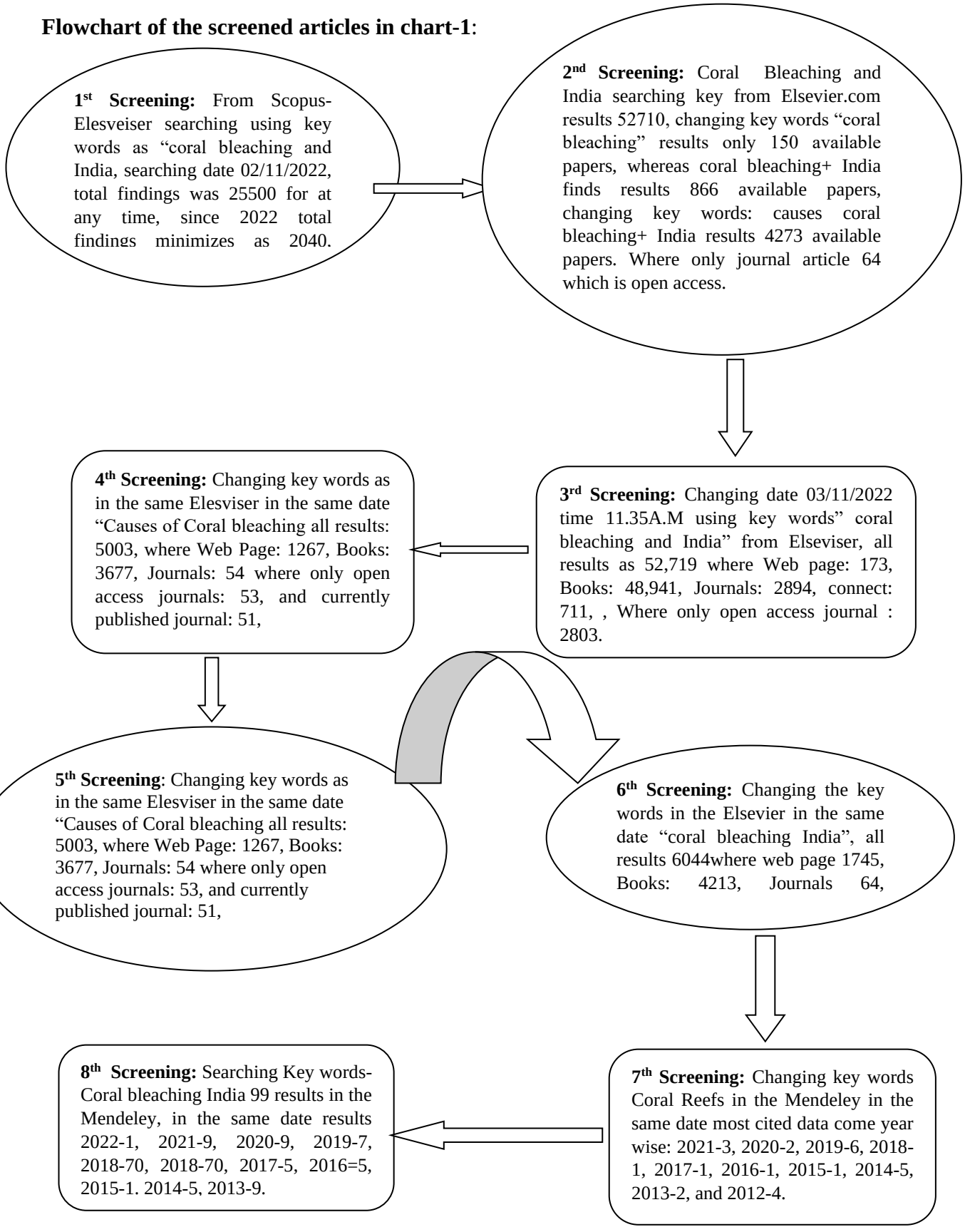
For example referred from Appendix the carried out systematic review in the form of Excel sheet, comes in the following word form in Table-2:

Item Type-1	Journal Articles
Publication Year	2022
Search Engine	Mendeley.
Journal or Book name.	ECS Transactions
Search Strings	Coral bleaching and India.
Author Name	Goswami, Mausumi, Goswami, Mausumi.

Title	Sustainability & amp Comparative Impact Analysis of Coral Reef Bleaching in Indian Context
Publication Title	Sustainability & amp Comparative Impact Analysis of Coral Reef Bleaching in Indian Context
Issue	1
Volume	107
Abstract	An estimated value of 500 million of the population are directly benefited through coral reefs related jobs, food and defence of coastal areas. Coral reefs help to reduce wave energy by 97%. They help to protect the coastal areas from storms, floods and wave energy by 97%. Natural disasters such as Tsunami and erosion of coastal areas are protected by reefs. In this process, they help to protect the lives of many staying in the coastal areas including animals, properties, and other natural resources. There are reasons for reef deterioration like change of climate, high pollution, destructive fishing, bleaching of coral reefs is a big concern now worldwide. Severe coral bleaching is also reported in India. A significant rise in the surface temperature of Sea has become a critical reason for coral bleaching. This work attempts to Study the link between sustainability, SDG goals of 2030 given by United Nations and coral bleaching. In this work study period is focused from 1985 to 2021 in the Indian coral reef bleaching areas.
Key Words	Impact, Coral Reef, Bleaching
Methodology	
Sample Size	Large, year from 1985 to 2021
STUDY Area	Indian Coral reef bleaching area.
Result	This work attempts to Study the link between sustainability, SDG goals of 2030 given by United Nations and coral bleaching.
Conclusion	This work attempts to Study the link between sustainability, SDG goals of 2030 given by United Nations and coral bleaching. In this work study period is focused from 1985 to 2021 in the Indian coral reef bleaching areas.
Paper Publication	yes
Citation	https://doi.org/10.1149/10701.11225ecst

E. Result Discussion

Flowchart of the screened articles in chart-1:

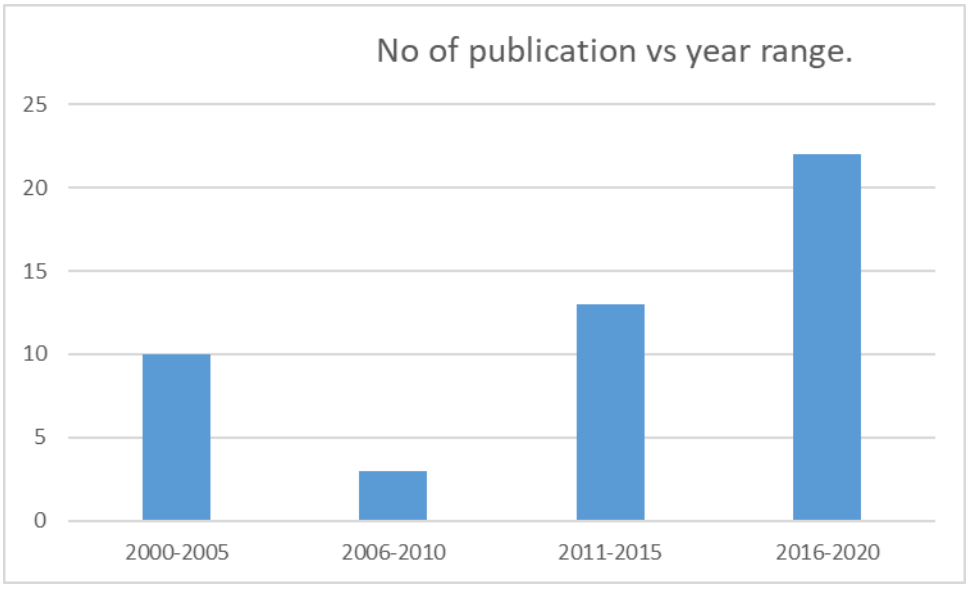


E. Result Discussion

From Excel sheet of systematic Review, applying filters give this following table-3

Year Range	No of Publication
2000-2005	10
2006-2010	3
2011-2015	13
2016-2020	22

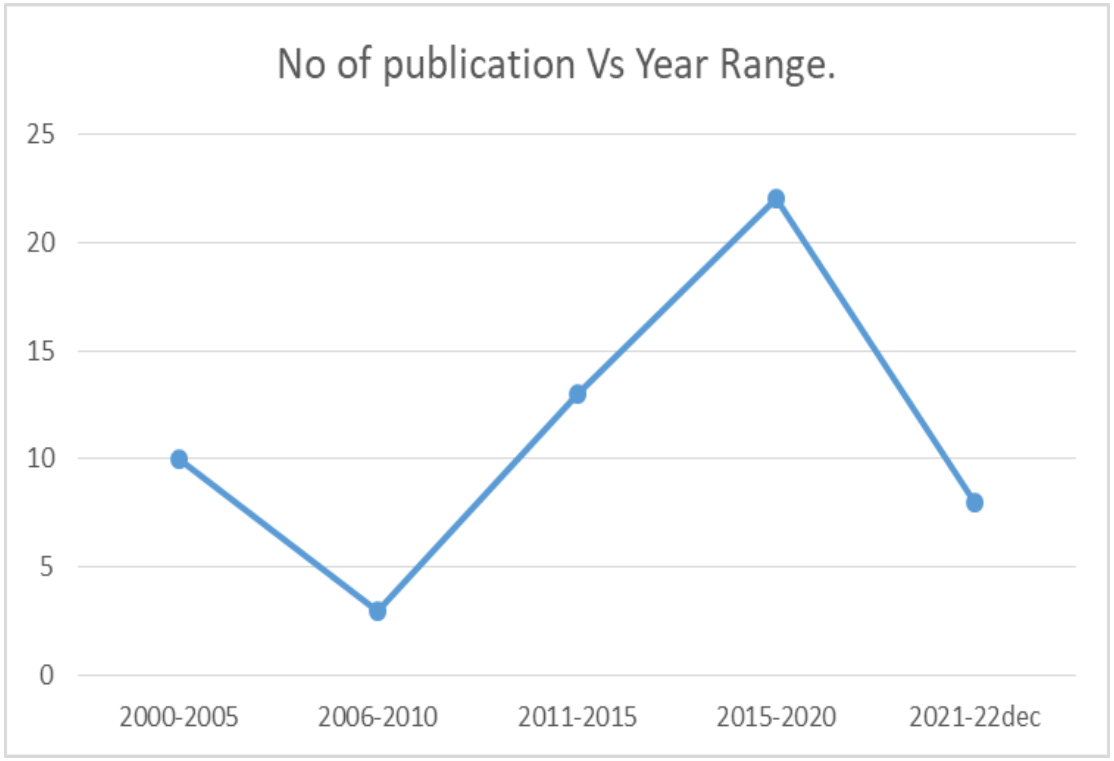
Putting into Bar diagram results shows as follows in graph-1:



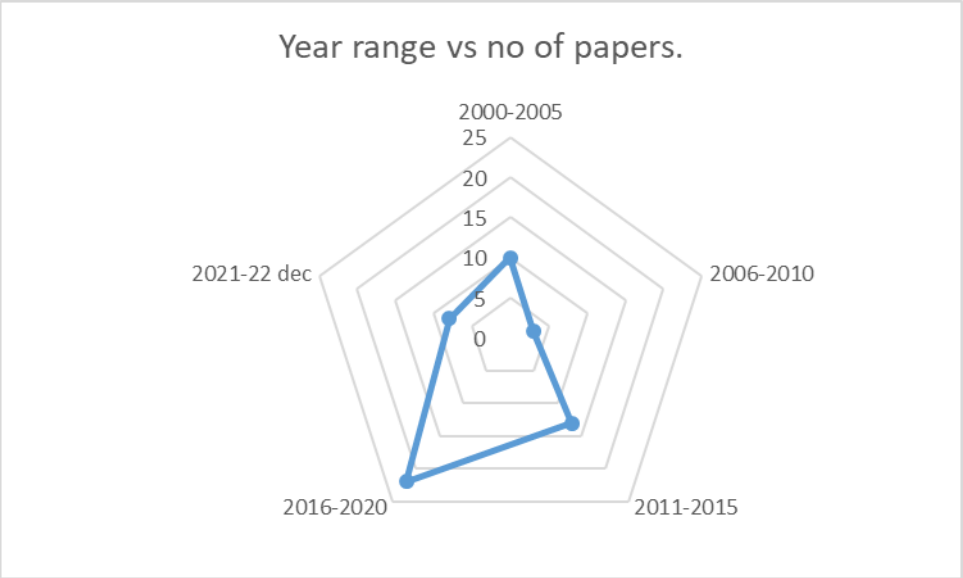
From Excel sheet in the Appendices of systematic Review, applying filters give this following table-4

Year Range	No of Publication
2000-2005	10
2006-2010	3
2011-2015	13
2016-2020	22
2020-2021 Dec.	8

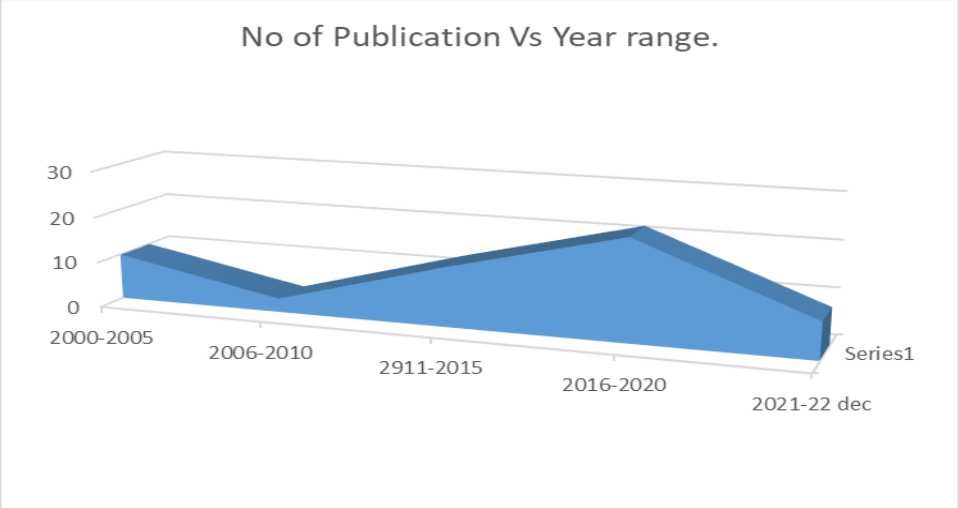
From table-4, excel sheet drawing gets (no of publication vs year range) graph no- 2



From table-4, excel sheet drawing gets (Zone vs no of papers) graph no- 3



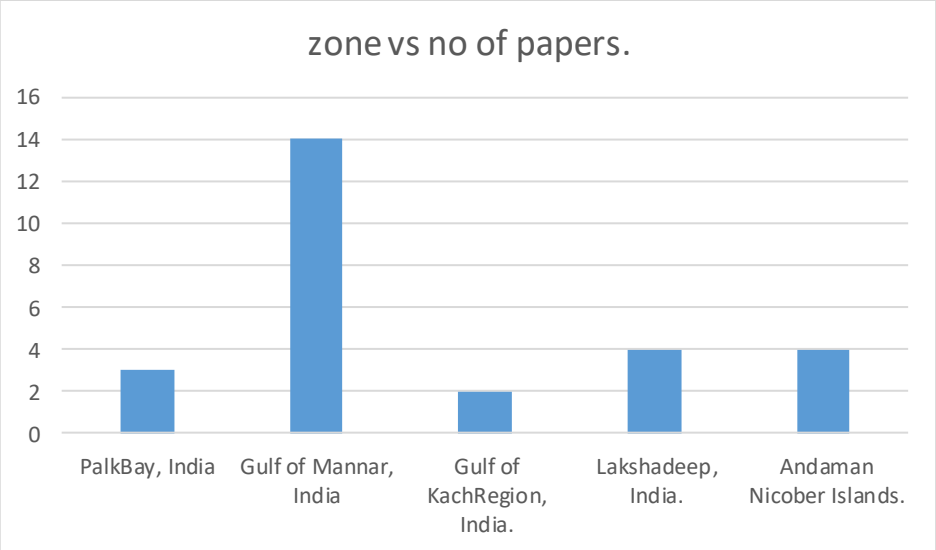
From table-4, excel sheet drawing gets (No of Publication vs year range) graph no- 4



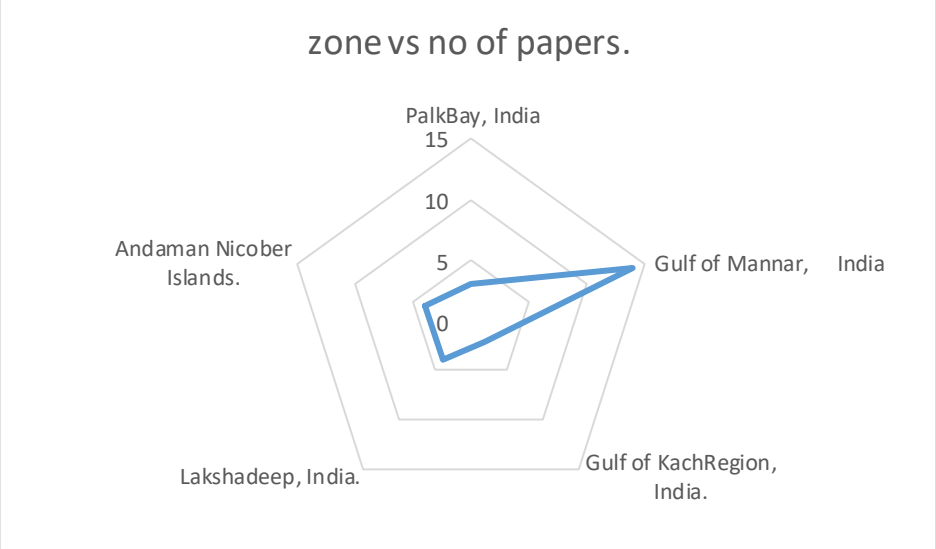
From Excel sheet of systematic Review, applying filters give this Table-5.

Zone	No of papers
PalkBay, India	3
Gulf of Mannar, India	14
Gulf of Kach Region, India.	2
Lakshadweep, India.	4
Andaman Nicober Islands.	4

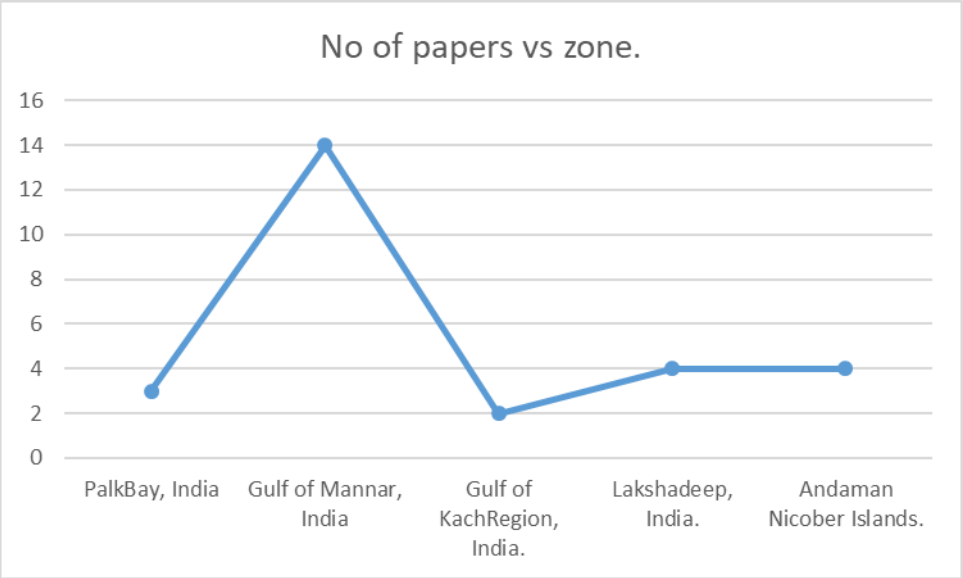
From excel sheet it finds the following zone vs no of papers graph no-5.



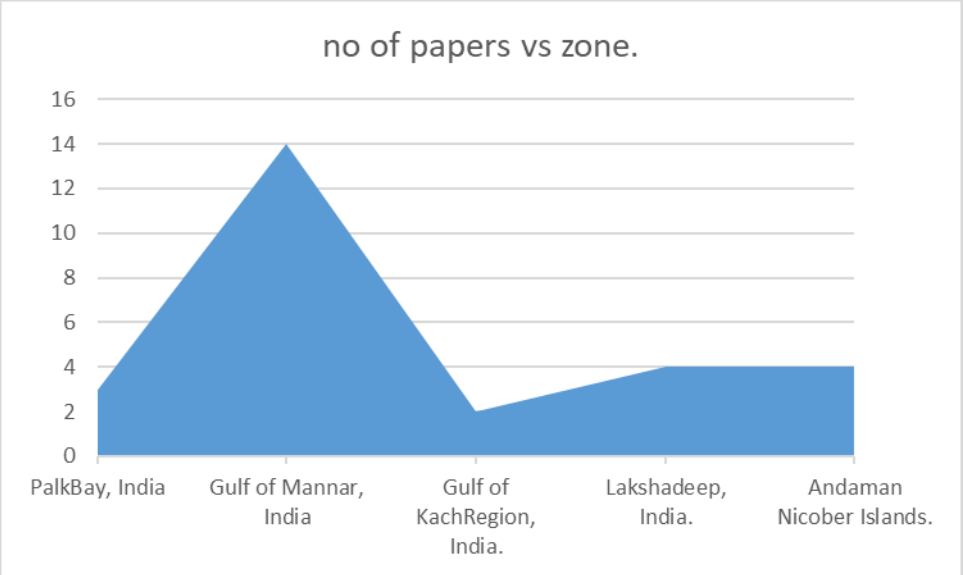
From table-5, excel sheet drawing gets (Zone vs no of papers) graph no- 6



From table-5, excel sheet drawing gets (Zone vs no of papers) graph no- 7



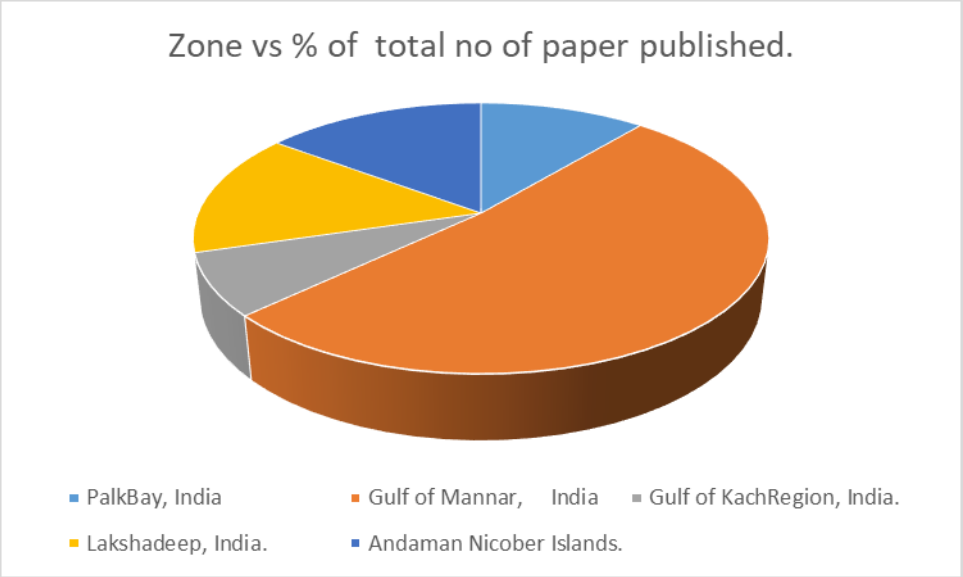
From table-5, excel sheet drawing gets (Zone vs no of papers) graph no- 8



From Excel sheet of systematic Review, applying filters give this Table-6.

Zone	% of total papers
PalkBay, India	11.111
Gulf of Mannar, India	51.851
Gulf of KachRegion, India.	7.40
Lakshadeep, India.	14.814
Andaman Nicober Islands.	14.814

From table-6, excel sheet drawing gets (Zone vs % of total no of published papers) graph no- 9



F. Conclusion and Discussion:

The majority of the studies that addressed the focal question of this systematic review were published between the years 2016-2020. The no of papers in terms of total no of papers is Highest in the Gulf of Mannar, India. Whereas Gulf of Kach, India has least no of papers. However, due to limited number of publications that addressed our review question we were unable to validate the full range of management techniques. . Nithyanandan, Manickam. (2016) first reported on. How reliable are the data on the recent coral bleaching event in Malvan Reef, India? Current Science.(14). Similarly, Goswami, Mausumi.(2022) Sustainability & amp Comparative Impact Analysis of Coral Reef Bleaching in Indian.Context.ECS.Transactions(1).

More studies are necessary to evaluate the potential for coral reef bleaching control, along with an assessment of risk. More the no of papers more knowledge to society more coral reef, less pollution, less bleaching.

Our oceans have no borders. This is a global crisis, but change starts here.

If we lose coral reefs we also lose a vast number of fish and other animals that rely on them. This will have terrible consequences right up the food chain impacting larger creatures, like dolphins and sharks that rely on reef fish for their diet.

Coral bleaching risks not just our oceans and wildlife, but the livelihood and food security of over half a billion people worldwide.

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