The Dead Zone-- Gulf of Mexico
Policy Brief: Improving the nitrogen pollution in the Gulf of Mexico Through Better Regulation System

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Recipient: Administrator of the Environmental Protection Agency, Andrew R. Wheeler

Justification: One of the roles taken by Andrew as an administrator of EPA is the environmental protection. As an administrator, he has a direct impact on the future policy setting as well as the development of the conservation program.

Executive Summary

Figure 1. Map of Mississippi River Basin and the Gulf of Mexico (EPA, 2001, p4)

The Gulf of Mexico is the river mouth of Mississippi-Atchafalaya River Basin. Huge amount of nitrogen and phosphorous are inflowing into the gulf every year. Nutrients primarily come from the N and P in the fertilizer which used in the agriculture for food and biofuel; artificial drainage, waste generated from human and livestock are also the source of nutrient. As the nutrients load increase, the production of organism such as algal increase which reduce the oxygen level leading to hypoxia or dead zone. The over enrichment of seawater is a serious environmental concern that put a huge threat on marine animal and largely driven up the seafood price. The research shown that the dead zone would cause approximately a $82 million loss on seafood and tourism industry. Alongside the amount of nutrients discharged, season change can also vary the size of the hypoxia.

In 1997, HTF established to reduce the nutrient flow as well as the size of hypoxia. In 2001, the first action plan (2001 action plan) was launched to develop the conversation programs of monitoring and research. It aimed to reduce the hypoxic area to less than 5000 km^2 by 2015. However, the plan was not fully successful. In 2008, the second plan initiated (2008 action plan). Based on uncompleted plans left from 2001, the 2008 action plan included better funding strategies, improved tracking, adapt to new scientific findings (EPA,2008, p19). In 2015, HTF announced an extension of the time of achieving the goal from 2015 to 2035.

This report recommend a number of policies to reduce the non-point pollution, this can be concluded in 3 aspects: mandatory, monetary as well as voluntary, these include introducing the law to force people to use less fertilizer, setting the nitrogen credit to control the amount of nutrient inflow; the monopoly power of fertilizer supply controlled by the government within the country; the shift of people's diet.

Empirical Analysis

The water which discharges to the Gulf of Mexico is from Mississippi River Basin (includes Mississippi, Ohio, and Missouri Rivers). The total area of watershed is 3 million km^2 and encompasses 40% of the territory (Mitsch, 2001, p373)

Intensive agriculture, artificial drainage as well as waste discharges from cites, suburbs and feedlots have led to the infusion of nutrients (Mitsch,2001, p374). Increased nutrients enhance the production of some organisms and decrease the oxygen levels (Rabalais et al, 2002). Nitrogen run-off enter into the gulf has led to the existence of hypoxia -- the presence of levels of oxygen is no more than 2 mg per liter (Leming and Stuntz 1984, Renaud 1986). It has been found that hypoxia is typically between 5 and 30m under the surface, the deepest one has been found up to 60 m (Rabalais et al, 2002).

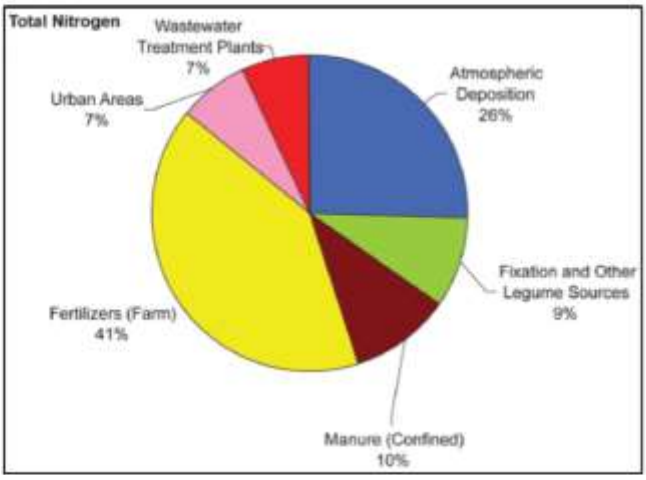

Figure 2. sources of nitrogen (Robertson and Saad, 2013)

The Gulf of Mexico dead zone is one of the largest in the world (Bruckner, 2017). Between 1985 to 2000, the area of hypoxia remained at an average of 15,900 km^2, it reached the peak at 22000 km^2 in 2000 and dropped to 10,500 km^2 for the period of 2003-2007 (Rabalais et al, 2007). In June 2017, the area of dead zone in the Gulf of Mexico was at 8,776 square miles (NOAA,2017) which was the largest measured since mapping began in 1985 (Imster, 2018). The size of hypoxia is also various in different seasons. In winter, the apparent oxygen utilization (AOU) is low and less oxygen depleted in the water. As the temperature gets higher, the freshwater discharge increases which intensifying the stratification then leading to the greater depletion (Bianchi et al, 2010, p1474).

The fertilizer used on corn cultivation to meet the demand for ethanol is the primary cause of hypoxia in the Gulf of Mexico (Donner al et, 2008, p4513). Within the growing season, it has been suggested that there is approximately a 45-50% loss of nitrogen applied to corn fields (Galloway and Cowling, 2002). Model simulation shown to achieve the 15 billion gallons of ethanol goal by 2020 can lead to the 22% decreased of area planted in soybeans and 10-18% increase in dissolved inorganic nitrogen flux (Donner al et, 2008, p4515). As the nutrient inflowed into the gulf, the deposition of organic matter which promotes microbial growth and leads to higher demand of oxygen. After that, the mortality rate of benthic animals starts to rise (Diaz, Rosenberg, 2008, p927).

Nutrient is essential for marine animals to survive at the low level, however, an overabundance can trigger excessive algal growth (EPA, 2001, p10) which would use up the oxygen in the gulf. The study shown that the amount of nitrogen and phosphorus inflow has increased two to three times over the last 50 years (NOAA, 2017). The nutrient over enrichment has imposed large impacts on marine ecosystem: the hypoxia area moves shoreward with tidal cycle which prevent blue crabs in crab traps from escaping low-oxygen waters and eventually die (Rabotyagov et al, 2014, p63). It has been suggested that the increase in hypoxia level would cause the severe reproductive impairment of marine animals; some small marine organisms will swim close to the surface as the deep ocean is hypoxia which expose them to predation (Rabotyagov et al, 2014, p63)

Apart from the degradation of water quality and huge threats on marine animals, hypoxia has also led to huge economic loss. Study in Duke University has found that the Gulf of Mexico 'dead zone' drives up the price of large shrimp relative to small shrimp, creating an economic impact that directly affects consumers, fishermen and seafood markets (NOAA, 2017). Such dead zone fits jellyfish better due to their lower demand of oxygen and food compared to commercially valuable fish (Richardson, 2009, p314). It has been suggested that the dead zone has approximately imposed the loss about $82 million a year on US seafood and tourism industries. (The Nature Conservancy, 2019)

Analysis of Empirical Evidence

Hypoxia Task Force (HTF) as a state partnership was established in 1997 aim to reduce excess N and P and to reduce the size of hypoxia in the Gulf of Mexico (EPA, 2017, p9).

The 2001 action plan which was a joint federal and state effort, consist with voluntary actions, incentives and education (Rabotyagov, 2014, p66). This included an environmental goal of reducing the average of the hypoxia area to less than 5000 km^2 by reducing the nitrogen loading by 2015 (Rabalais, Turner and Scavia,2002, p139). The plan initiated in Dec 2000, starting with submitting an integrated fund for research, education as well as developing monitoring program. Between 2001 to 2003, HTF had planned to focused on research strategy of nutrient reduction as well as expand monitoring program in both gulf and basin through states and tribes (EPA, 2001, p13-14).

By 2008, some actions in 2001 plan has not been initiated or completed, the main failure includes the knowledge gaps of the science, unsubmitted integrated fund, underdeveloped water quality monitoring program and the uncertainty of pollution contributed by non-point pollution source (EPA, 2008, p19-20). The 2008 action plan released by HTF focused on promoting effective conservation practices, reducing point source discharges, developing tracking progress, decreasing existing scientific uncertainties and increasing awareness of Gulf hypoxia (EPA, 2015, P14).

In the Mississippi River/Gulf of Mexico Watershed Nutrient Task Force 2015, the HTF agreed on an interim target of a 20 percent nutrient load reduction by the year 2025 as a milestone toward reducing the hypoxic zone to less than 5,000 km2 by the year 2035 (EPA, 2017, p10). In the same year, $5.7 million was obligated in National Water Quality Initiative (NWQI) watersheds in the HTF states within the Mississippi-Atchafalaya River Basin. Thus, at least one watershed per state is monitored by state water quality agencies to track water quality responses to nutrient, sediment, and pathogen conservation practices (EPA et al, 2016, p25).

Model development is also playing an important role of improving the nitrogen pollution. The National Water Model developed by the NOAA'S National Water Center was released in 2016 which increased the forecast sites from 4000 to 2.7 million. This would also help to forecast the water quality by 2023 (EPA, 2013, p17)

The high investment in the monitoring system and model will help the government to be able to predict the future change and take the corresponding actions. However, Long-term monitoring strategy is one of the key implementation actions, environmental trends and variables should be quantify (EPA, 2001, p25).

Policy Suggestion:

The current policies have not reduced the area of hypoxia, as shown in figure 2 above, the 5-year average value (red line) was still far beyond the 5000 km^2 target. Therefore, HTF need to introduce more stricter regulations as well as improve the monitoring system.

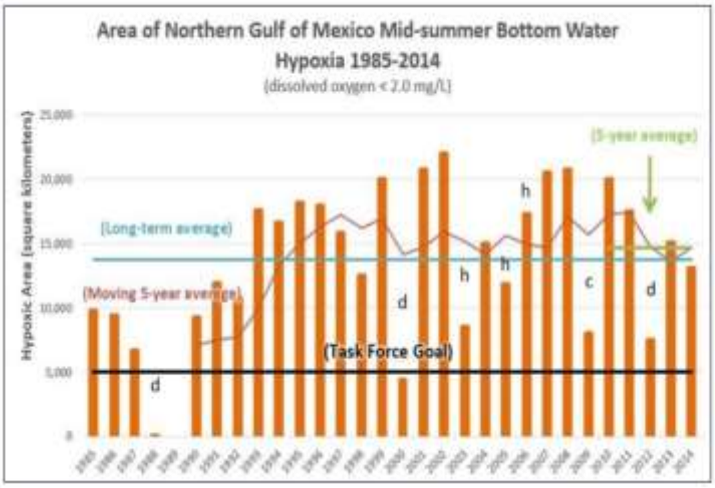

Figure 3. The size of hypoxic area against time (EPA, 2015, P11)

Using fewer fertilizers will significantly limit the runoff of excess nutrients from farmland. It has been suggested that a small reduction in such nitrogen input is unlikely to have reduced crop yields significantly (McIsaac, 2008, p166). Regulation such as setting a heavy punishment if the level of fertilizer used in the agriculture has highly excessed the reasonable level.

Water Quality Trading (WQT) also referred to as Nutrient credit trading is a cost-effective approach to reduce the nutrient loading (EPA, 2015, p70). It was firstly developed in the Ohio River Basin by the Electric Power Research Institute. Then implementing in Indiana and Kentucky (EPRI, 2014, P1). It was a fully voluntary. The likelihood of receiving financial benefits by selling credits is the incentive to participate (EPRI, 2014, P1). Based on this, the government should make the WQT oblige and expand it to all the states adjacent to Mississippi River Basin.

Alongside the nitrogen credits, effectively controlling the amount of fertilizer is crucial for solving the pollution. This can be done through having the monopoly power of selling fertilizer within the country. In other words, the government is the only seller of fertilizer in the country. Scientists work for EPA could estimate how much fertilizer each farmer actually needs according to the size of the farm to minimise the effects to the river from the agriculture. In addition, it also protects small or medium size farm since the government can set a relative lower price of the fertilizer than the market price.

Besides, monitoring is also crucial for reducing the area of hypoxia. The government should keep tracking the level of nutrient in the water by setting more monitoring points along Mississippi River Basin. Regularly collecting the sample from each point and testing the percentage of nutrient contained in the sample can help to control the amount of nitrogen discharged and also narrow down the area of nonpoint pollution source once the level of nitrogen excesses the target level.

Furthermore, the monetary support from the US government on the model development is necessary. Learning the impact of actions as well as using the understanding to plan future action are the most important of adaptive management. Using the model to predict the future impact is also essential for mitigating the problems (EPA, 2007, P155). Models such as (SWAT, HUMUS) has developed to examine nutrient in the basin which has reduced the loading by 18-20 percent (EPA, 2017, P33). As mentioned above that the areas of hypoxia can be varied according to seasons change. Therefore, it is necessary for scientists to forecast the best time in a year for applying fertilizer. Such forecasts can prevent fertilizer from running off, thus minimize both the cost of farmer and the impact to the ecology.

Finally, model simulations show that a 34% decrease in annual mean DIN flux would be achieved combining the shift in food production and diet with construction of riparian wetlands adjacent to all corn and soybean lands (Donor et al, 2008, p4517). While developing a future strategy planning is more important and essential to reduce the pollution and mitigate threats to ecosystem.

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