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REJUVENATING THE TENGRATILA BLOWOUT ZONE BY PERFORMING UNCONVENTIONAL RECLAMATION PROCESS

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Abstract*- This paper aims at finding different solutions to how to alleviate the impact of blowout in Tengratila. It proposes some steps that can be helpful for the economic use of the blowout zone and its surroundings. By cultivating "Aerobic Methanotrophs" in the blowout zone we can reduce the methane emission. However, a study shows that in 10,000 parts per million volume (p.p.m.v.) methane amended microcosms, the methane concentration can be decreased to as low as 0.6 p.p.m.v. In addition to reducing methane content it can also be conducive to the increased yield of paddy fields. Natural gas blowout is one of the major hazards, causing damage to the reservoir and gas bearing formation, and damaging the environment. There were two blowouts in Chhatak-2 (Tengratila) in 2005. An Environmental Impact Assessment (EIA) of the gas field after blowout has been carried out and the results of the study shows that the explosion caused widespread environmental damage and huge losses of natural resources. So it is very necessary to mitigate the impact of blowout in the affected zones. A regional planning of Tengratila is also included in this paper for optimum utilization of the reclamation and restoring process. It will help to prevent the wastage of valuable land resources of Bangladesh.*

Keywords: Tengratila blowout, environmental damage, methane emission, aerobic methanotrophs, land management, unconventional reclamation.

1. INTRODUCTION

Natural gas, a primary source of energy, has critical role in socio economic development in Bangladesh. The Chhatak-2 (Tengratila) Gas Field located within block 12 was discovered in 1959 and it was in production for several years by a single well. The gas field is situated in Balijuri mouza of Lakshmipur union at Dowarabazar upazila in Sunamganj district, Bangladesh. The geographical location of Tengratila Gas Field is 25º04'44"N latitude and 91º32'42"E longitudes. There were two blowouts in Tengratila in 2005. An Environmental Impact Assessment (EIA) of the gas field after blowout has been carried out and the results of the study shows that the explosion caused widespread environmental damage and emitted methane at very high rates. The blowout zone is still leaking methane after 12 years of blowouts. On May 2016, Petrobangla made a study conducted by a foreign expert team. The expert team monitored the long term effects of blowout. Although according to the National Institute for Occupational Safety and Health (NIOSH) maximum recommended safe methane concentration for humans during an 8-hour period is 1000 parts per million volume (p.p.m.v.), it was found that the rate of methane emission is approximately 30,000 p.p.m.v in the air at the blowout spot and 50 p.p.m.v in the air at a distance of 500 meters from the spot of blowout. The atmosphere generally contains about 2.2 p.p.m.v. of methane. At the starting of any physical petroleum exploration site rehabilitation, closure objectives and a detailed plan of action need to be established. The essential goal of site reclamation is to return all affected areas, as near as possible, to their optimum economic value. This does not always involve returning a site to its original state or use. The aims of site reclamation are to reduce the risk of pollution, to restore the land and landscape, to improve the aesthetics of the area, to prevent further degradation and to provide for future economic use. As the Chhatak-2 (Tengratila) gas field and its surroundings is completely destructed by the blowout, conventional reclamation process will not be effective and applicable. So we aim at finding different solutions to how to alleviate the impact of blowout in Tengratila by cultivating aerobic methanotrophs. Aerobic methanotrophs can highly reduce the rate of methane emission in the blowout zone. Methane oxidation is a microbial metabolic process for energy generation and carbon assimilation from methane that is carried out by specific groups of bacteria, the methanotrophs. Under aerobic conditions, they combine oxygen and methane to form formaldehyde, which is than incorporated into organic compounds via the serine pathway or the ribulose monophosphate (RuMP) pathway. Type I methanotrophs use the RuMP pathway to assimilate carbon and type II utilize the serine pathway. HAMO (High affinity methane oxidation) occurs at CH_4 concentrations close to that of the atmosphere (<12 p.p.m.v.).

Atmospheric methane is consumed by microorganisms in aerobic upland soils that are predominantly exposed to near- or sub-atmospheric methane concentrations at the exceptionally low level of 1.84 p.p.m.v. Theoretical calculations of soil methane consumption dynamics indicate that atmospheric methane does not supply enough maintenance energy for any known methanotrophs to survive[1]. So in the blowout zone where the methane emission rate is too high can provide enough maintenance energy for methanotrophs to survive. Existing evidence regarding responsible microbes that possess high-affinity methane oxidation (HAMO) enzymes points to as yet uncultured methanotrophic lineages. These lineages are comprises upland soil cluster alpha (USCα) and upland soil cluster gamma (USCγ), which are frequently detected in aerobic upland soils, such as those in forest and grassland regions, but not in wetland soils[2-4].

2. LITERATURE REVIEW

Rice paddies can serve as a model system for periodically draining wetland ecosystems because the practice of agricultural rotation is commonly used with waterlogged rice cultivation and upland wheat in Bangladesh. Thus, using paddy soil as a model system to mimic the fluctuating availability of methane in periodically draining wetland soils by exposing it to various methane mixing ratios. Results showed that the HAMO activity for 1.84 p.p.m.v. methane uptake emerged only after soil oxidation of methane at 10,000 p.p.m.v. and ceased after 2 weeks, but could be regained after re-exposing the soil to 10,000 p.p.m.v. methane. Feeding the soil with 10,000 p.p.m.v. methane for 10 days on a daily basis led to a greater endurance of HAMO activity, although the growth of methanotrophic populations was progressively constrained.

It suggests that a critical level of methane turnover might be required for the emergence and resilience of soil HAMO activity. Investigating methane oxidation dynamics by incubating paddy soil under aerobic conditions with methane at five different mixing ratios, including ~2 p.p.m.v. in the ambient condition and 100, 500, 1,000 and 10,000 p.p.m.v. for the elevated concentrations, no methane oxidation occurred in the soil when exposed to ambient air and 100 p.p.m.v. methane over the 18-day incubation period (Fig. 1a). However, in the 10,000 p.p.m.v. methane-amended microcosms, the methane concentration dropped rapidly to ~2 p.p.m.v. within 3 days and further decreased to as low as 0.6 p.p.m.v. (Fig. 1a), suggesting the emergence of HAMO activity in this soil. Intriguingly, in the 500 and 1,000 p.p.m.v. methane amended microcosms, HAMO activity was not induced, although the induction of HAMO activity in paddy soils.

Incubating the soil again with a single exposure to 10,000 p.p.m.v. methane (1-time flush-feeding, 1-TF) or with 10,000 p.p.m.v. methane for 10 days (10-time flush-feeding, 10-TF) by renewing the headspace gas once a day (Fig. 1b) the emergence of HAMO activity was verified. During the 10-day incubation period, a marked increase of the methane consumption of the soil was observed after 3–4 days of incubation. However, subsequent replenishment of the 10,000 p.p.m.v. methane led to a steady decrease in the methane oxidation, pointing towards possible nutrient deprivation given the excessive supply of methane-derived carbon (Fig. 1b).

Nevertheless, the HAMO activity of the 1-TF soil showed a decreasing trend over time and was lost after 2 weeks (Fig. 1c). Intriguingly, this HAMO activity could be induced again on incubation with elevated methane (10,000 p.p.m.v.), despite subsequently losing HAMO activity as before (Fig. 1c).

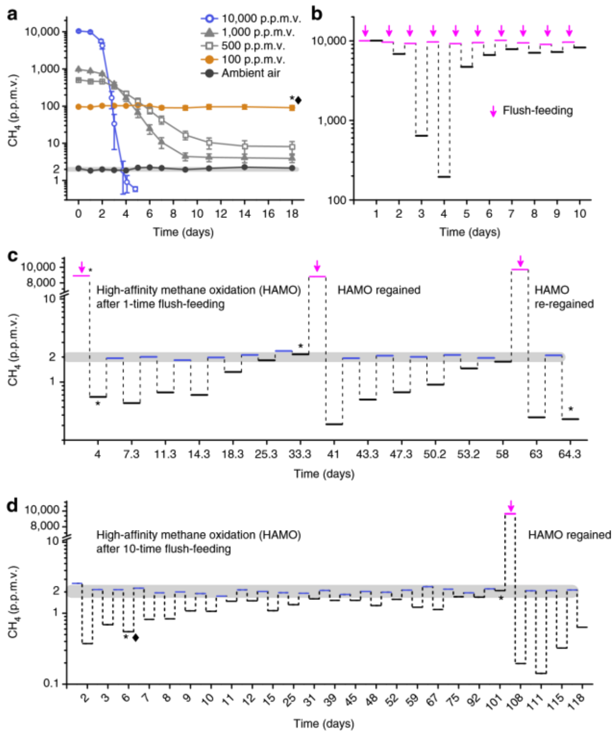

Fig.1: Emergence and resilience of High Affinity Methane Oxidation (HAMO). (a) The consumption dynamics of methane under different initial mixing ratios. High-affinity methane oxidation (HAMO) activity occurred only in soil amended with 10,000 p.p.m.v. (b) Methane consumption changes in 10-time flush-feeding microcosms with 10,000 p.p.m.v. methane. The headspace methane was replaced every day to maintain 10,000 p.p.m.v. methane. Red bar: initial methane mixing ratio after each replacement; black bar: methane mixing ratio after 1 day of incubation. Gradual losses and regain of HAMO activity are shown after 1-time (c) and 10-time (d) flush-feeding [5].

3. METHODOLOGY

First of all aerobic methanotrophs have to be isolated from the nearest paddy fields of the blowout affected zone. Then the isolated methanotrophs can be cultivated in the affected zone. Later a regional plan is established based on the methane emission rate at the blowout zone which was measured by Petrobangla.

3.1 Isolation of Aerobic methanotrophs

Isolating efficient methane degrading bacteria (methanotrophs) from natural habitats may present a near long term advantage in solving the methane emission problem. For isolation of methanotrophic bacteria from wet land paddy soil samples can be collected at flowering stage representing major traditionally rice growing areas of the blowout affected zones. The soil samples from rhizospheres of rice roots should be collected in sterile High-density polyethylene (HDPE) bags and brought to the laboratory and processed immediately after collection.

1 gm of soil (wet weight) can be inoculated in an enrichment flask containing sterile Reverse osmosis (RO) water containing desired minerals as basal medium. Basal medium is an unsupplemented growth medium used to culture bacteria which do not need special nutrients. The flasks were than sealed with rubber cock tightly supplemented with 1% methane gas and enriched for 15 days. After enrichment bacterial growth is purified on Nitrate mineral salts (NMS) agar medium incubated in anaerobic jar containing methane gas. Agar medium is a plate on which micro-organisms are cultured, and their sensitivity is tested [6].

3.2 Regional Planning of the Blowout Zone

A regional plan has to be established for the blowout affected zone with the help of an urban and regional planner. The affected site will be divided into sections for detailed planning. In the high concentration methane emission zone aerobic methanotrophs will be cultivated. The surrounding zone will also be under consideration. The Sylhet upazila map shapefile was downloaded from the Local government engineering department (LGED) website. Shapefile is a simple, non-topological format for storing a geometric location. Then, the shapefile is used to project and represent with ArcGIS 10.1 to produce maps and make decision by analysis. For creating this planning the longitude and latitude has been taken from google earth map for finding the location of blowout point in Tengratila. Then a point feature has created with the longitude and latitude to locate the blowout point of Tengratila in Dowarabazar upazila in Arc Catalog.

4. RECOMMENDATIONS

From the results of the experiment it is justified that cultivation of aerobic methanotrophs can be useful in high methane concentration zones. So in the blowout zone in Chhatak-2 it can be applied. In the blowout zone where the methane concentration is very high (>10,000 p.p.m.v.) aerobic methanotrophs should be cultivated immediately.

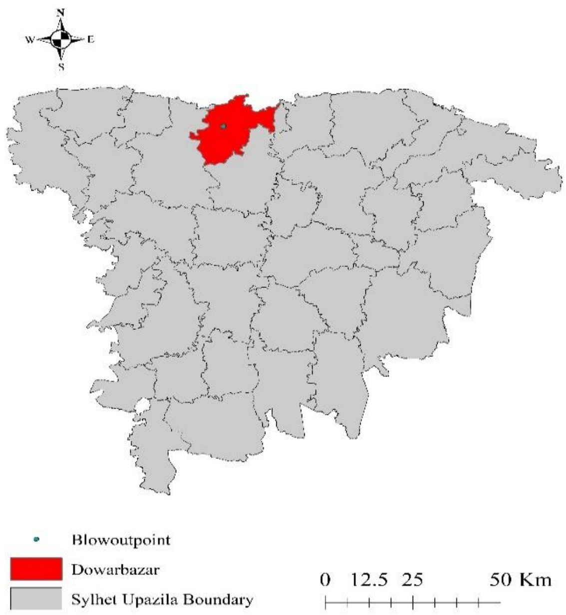

Fig.2: Blowout zone in Chhatak-2(Tengratila).

We recommend a zone of 100 meter radius from the blowout point which land could be used for the methanotrophs cultivation (shown in Figure 3). As the soil condition and agricultural behavior of our country matches the condition of experiment, it can be easily implemented. In the first 100 meters zone there should not be any human habitation.

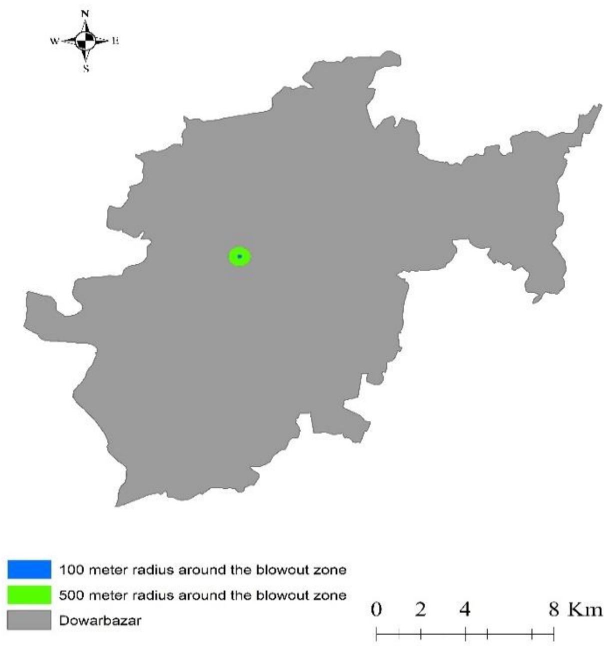

Fig.3: Zone at which aerobic methanotrophs can be cultivated.

Where the methane concentration is low like some 500 meters from the blowout point this land can be used for cultivation of paddy in parallel with aerobic methanotrophs as shown in Figure 4.

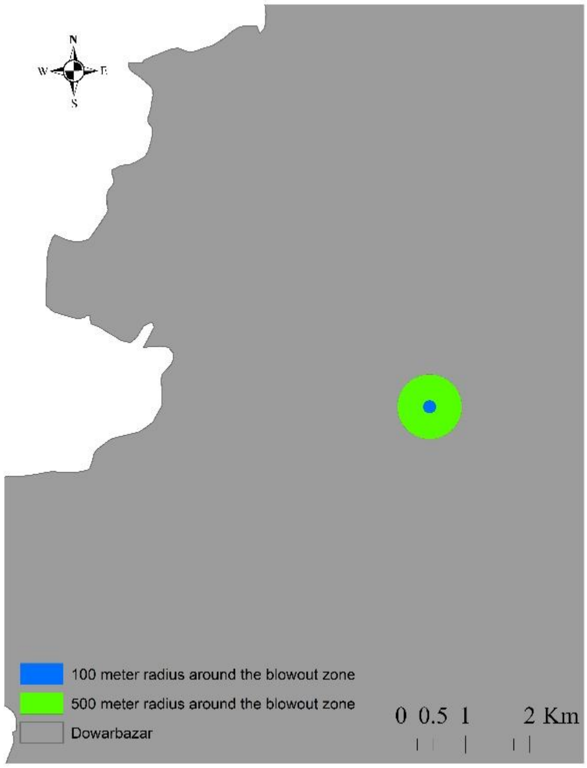

Fig.4: 100 and 500 meters radius around the blowout.

Human habitation is possible in this area as the concentration of methane emission is much less.

5. CONCLUSION

The losses of blowout are irrecoverable for a developing country like Bangladesh and it is hard to calculate them in money. Not only is the loss of money, but also environmental degradedness is one of the biggest concerning issue. The effect may not appear in economy just after the accident, but in the future, the country will suffer for a long period of time both economically and ecologically. In this paper we tried to propose a solution for reducing methane emissions in Tengratila. The practical utilization of the method can be highly effective in our country. Thus it can also provide a habitable land after some years and it is very necessary for the local habitants and farmers.

6. REFERENCES

[1] Bender, M. & Conrad, R. Kinetics of CH_4 oxidation in oxic soils exposed to ambient air or high CH_4 mixing ratios. FEMS Microbiol. Lett. 101, 261–269 (1992).
[2] Kolb, S. The quest for atmospheric methane oxidizers in forest soils. Environ. Microbiol. Rep. 1, 336–346 (2009).
[3] Holmes, A. J. et al. Characterization of methanotrophic bacterial populations in soils showing atmospheric methane uptake. Appl. Environ. Microbiol. 65, 3312–3318 (1999).
[4] Knief, C., Lipski, A. & Dunfield, P. F. Diversity and activity of methanotrophic bacteria in different upland soils. Appl. Environ. Microbiol. 69, 6703–6714 (2003).
[5] Yuanfeng Ca, Yan Zheng, Paul L.E. Bodelier, Ralf Conrad & Zhongjun Jia," Conventional methanotrophs are responsible for atmospheric methane oxidation in paddy soils", *Nature Communications*, DOI: 10.1038/ncomms11728.
[6] Jhala Yogeshvari K, Vyas Rajababu V, Panpatte Deepak G, Shelat Harsha N (2016) Rapid Methods for Isolation and Screening of Methane Degrading Bacteria. J Bioremediat Biodegrad 7: 322. doi:10.4172/2155-6199.1000322.