Juni Khyat
(UGC Care Group I Listed Journal)
ISSN: 2278-4632
Vol-10 Issue-09 No.03 September 2020

A Comparative Study of different Sewage Treatment Technologies

[1]RAMA NARAYAN SABAT,
Gandhi Institute of Excellent Technocrats, Bhubaneswar, India
[2]PRITAM KUMAR BALIARSINGH,
APEX Institute of Technology & Management, Bhubaneswar, Odisha, India

Abstract - *The construction of wastewater treatment plants based on latest emerging treatment technologies with effectiveness is necessary. It must be based on an environmentally friendly approach to reduce problem of water pollution which is rising rapidly on global scale, especially in those regions where accessibility to pure water is in challenging phase. The conventional technologies employed for waste water treatment have become less effective to treat the ever-increasing loads of wastewater. Thus, resulting in high energy consumptions and malfunctions. Additionally, these facilities engulfed by the cityscape, razing land and diminishing value transforms into unsustainable in the long run. Therefore, for improvement & efficiency of service delivery especially in urban sanitation sector the set of Standardized Service Level Benchmark has been formulated to tackle the problem of pollution. National Green Tribunal (NGT) has taken a serious view of pollution in the drains, streams and rivers and is monitoring the quality of rivers. The objective of this study is based on the comparative study of different technologies adopted in Wastewater Treatment Plants and outline a set of criteria for selecting an appropriate technology. In the proposed work, SBR Technology based STP is selected on the basis of the criteria evolved. SBR Technology produces effluent of high quality and meet regulatory standard. The overall treatment efficiency in terms of removal of BOD, COD, SS, Ammonia Nitrogen (N), Total Kjeldahl Nitrogen (TKN) and Total Phosphorous (TP) founds to be satisfactory against the treatment of the organic load*

Key Words*: *Technologies, Effectiveness, Appropriate, Regulatory Standard.

1. INTRODUCTION

Wastewater contains a spread of organic and inorganic constituents thus, one amongst the foremost critical issue for environment degradation because of its chemical and toxic constituents, and its bacteriological status. So, before discharging the waste products into water bodies, effective treatment of wastewater is incredibly crucial to take care of the healthy and disease-free life. The most important challenge in wastewater management in developing countries nowadays is the application of low-cost wastewater treatment technologies that can produce the effective effluent to meet the regulatory standard for domestic, agricultural, and industrial purposes (Jhansi, 2013). Since wastewater also contains reusable resources such as water, carbon and nutrients that could be recovered or reused (Crawford, 2010). These objectives can be met if a sewage treatment system is well-designed. The main concern should be towards the prevention of spread of diseases, recovery of nutrient, reuse of water and to conserve the water resources. It must be ensured that quality of treated water is improved to reach the permissible level of water for re-utilization or to be discharged into water bodies as per the latest guidelines of H'onorable National Green Tribunal (NGT). The NGT order requires a high-quality effluent, more emphasis should be laid to recycle or reuse the treated wastewater with little or no need for additional treatment to avoid future water shortages and to reduce the damage to the environment.

2. SIGNIFICANCE OF THE STUDY

The wastewater contains huge quantity of macrobiotic, inorganic and toxic matter which are dangerous for aquatic, human and environment life. Due to weak regulations, improper management, economic situation and selecting unsuitable technologies, the goal of wastewater treatment is not achieved and the problem continues. Thus, traditional wastewater treatments need to be upgraded into sustainable treatments to achieve today's overall goals of wastewater treatment to achieve the revised limits set by the National Green Tribunal. Selecting suitable technology is crucial to solve the problem. More emphasis is to be laid on different degrees of treatment depending on the final use of this reclaimed water and proper discharge. Thus, the primary objective of this research study is to evaluate the performance of different types of treatment technologies so as to develop guidelines for adopting the most appropriate technology under given conditions. The prime objective of this study is to review and compare different wastewater treatment technologies in order to select an appropriate technology based on sustainability, efficiency, and reliability to meet the desired standards of treated effluent. In order to achieve this, common treatment technologies being employed are identified, studied and compared. Then, a set of decision criteria for selecting an appropriate wastewater treatment process based on efficiency, capital cost and land requirement is developed.

3. CRITERIA FOR THE SELECTION OF APPROPRIATE STP TECHNOLOGY

Fundamentally, there are three important criteria namely performance, cost, and sustainability which needs to be evaluated for selecting the appropriate treatment technology for wastewater treatment.

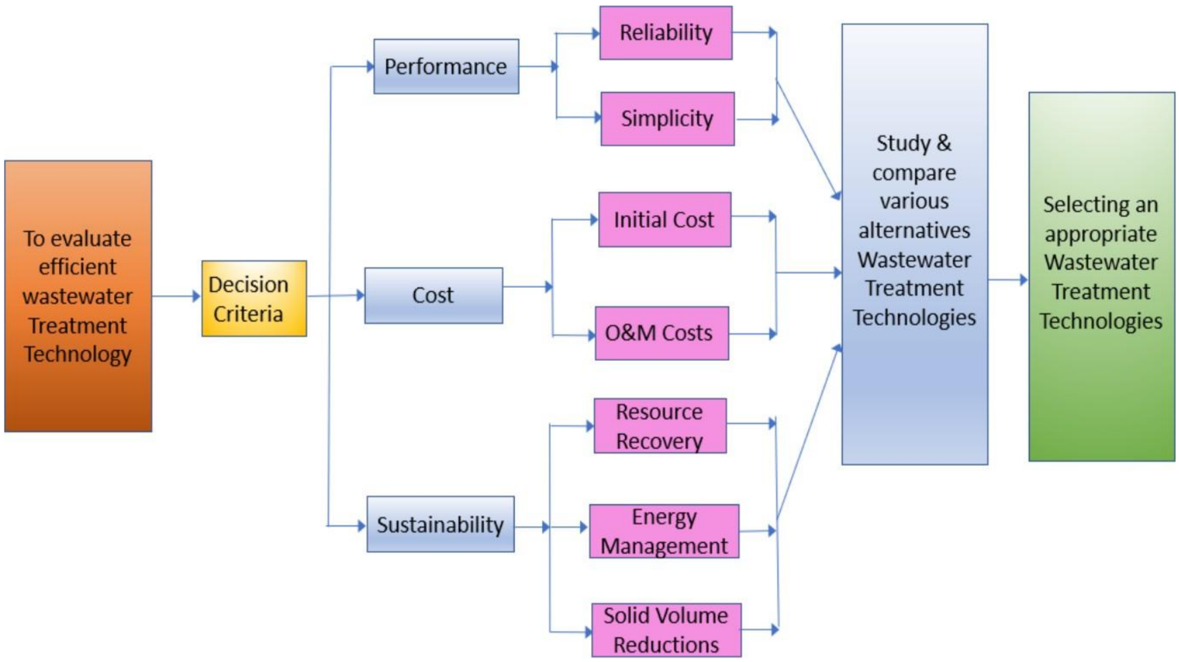

Chart -1: **Flow Chart showing Selection Criteria (Wongburi P. et. al, 2018)**

4. Analysis of existing Wastewater Treatment Plants in India

In order to assess the latest status on wastewater generation, it is most important to study the ground reality of water and wastewater treatment scenario in India. This section of the report is based on the comprehensive assessment of Sewage Treatment Plants in India carried out by CPCB in the year 2020-21. The data such as location, capacity, and total number of treatment plants based on various treatment technologies is collected and used to determine the most prevailing technology being effectively used in the country. The treatment capacity distribution in percentage among various States is depicted in Chart-2 and Sewage Treatment Capacity Distribution Technology-wise is shown in Chart-3.

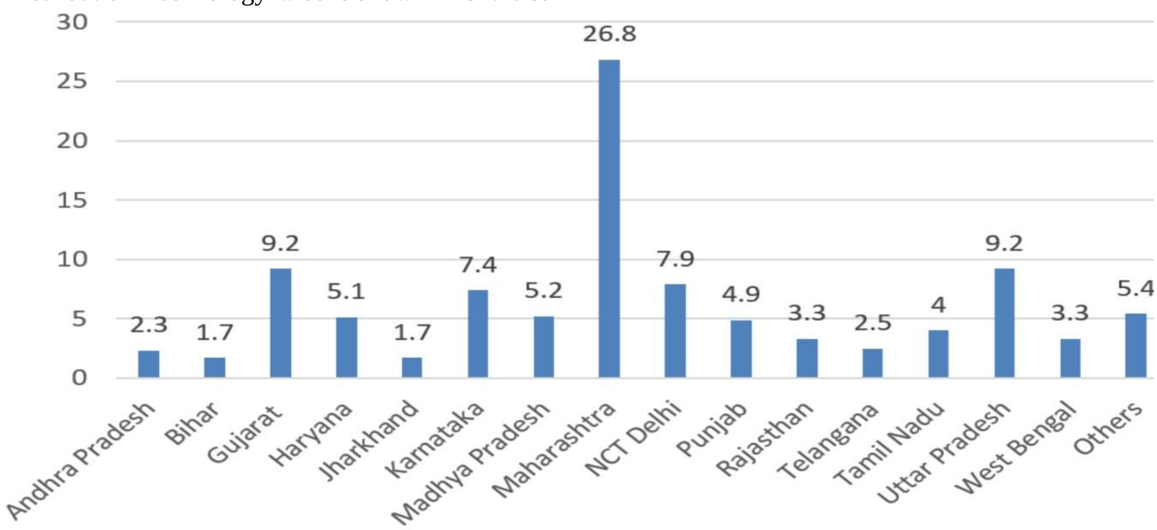

Chart -2: Sewage treatment capacity distribution (in Percentage)

ISSN: 2278-4632
Vol-10 Issue-09 No.03 September 2020

rom Chart-2, it is inferred that States of Maharashtra, Gujarat, UP, NCT of Delhi and Karnataka have installed significant sewage treatment facilities.

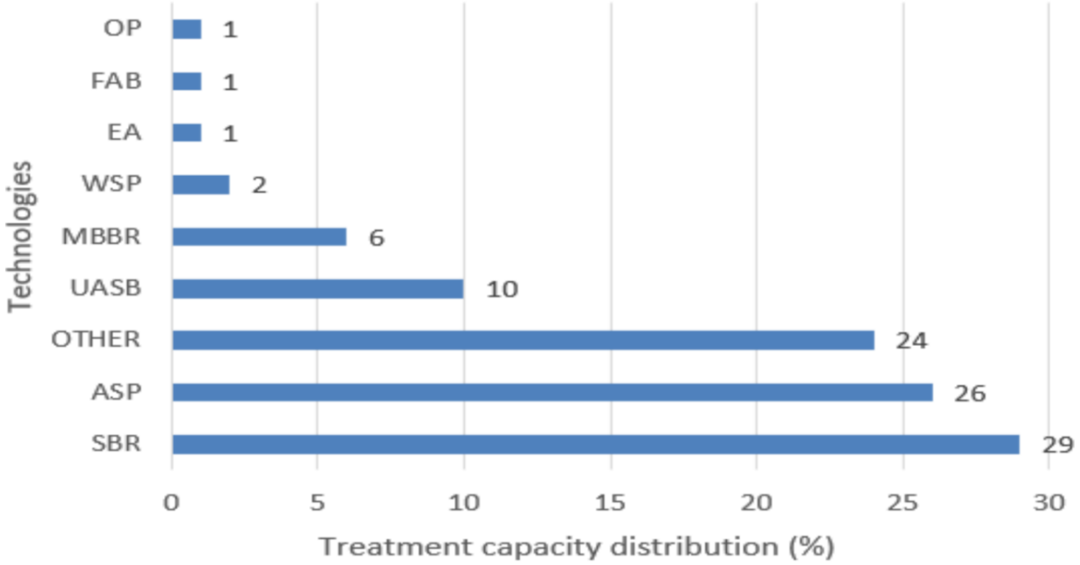

Chart -3: Technology-wise sewage treatment capacity distribution (in Percentage)

From above Chart-3, it is observed that Sequential Batch Reactor (SBR) and Activated Sludge Process (ASP) are the most prevailing technologies adopted in the country.

5. COMPARISON OF DISCHARGE STANDARDS BY DIFFERENT POLLUTION CONTROLLING BODIES

The review of various standards for discharge of treated effluent laid down by CPHEEO, Ministry of Environment, Forest and Climate Change (MoEF & CC), Central Pollution Control Board (CPCB), Punjab Pollution Control Board (PPCB), National Green Tribunal (NGT) has been made and is discussed as under:

Table 1: Comparison of discharge standards by different Pollution Controlling Bodies

S. No	Parameters	CPHEEO Manual	MoEF & CC	PPCB	NGT
1.	pH	-	6.5-9.0	6.5 to 9.0	5.5 to 9.0
2.	BOD5 (at 20□C), mg/l	<10	< 20 or 30 (Metros or areas)	≤ 10	≤ 10
3.	COD, mg/l	-	-	≤ 50	≤ 50
4.	Total Suspended Solids , mg/l	<10	<50 or 100 (Metros or areas)	≤ 10	≤ 20
5.	Faecal Coliform MPN/100 ml	<230	< 1000	Permissible ≤230 Desirable ≤100	Permissible ≤230 Desirable ≤100
6.	Phosphorous, mg/l	<2	-	≤ 2	≤ 1
7.	Ammonical Nitrogen as N, mg/l	-	-	≤ 5	-
8.	N-Total, mg/l	<10	-	≤10	≤10

6. COMPARATIVE STUDY OF DIFFERENT TECHNOLOGIES FOR WASTEWATER TREATMENT

A Comparative study of different Technologies for wastewater Treatment has been made considering key parameters such as performance, efficiency, treatment costs, O&M costs, energy cost and land requirement. The proposed work is based on the research study conducted by various organizations in the year 2010 and are discussed below:

Table 2: Comparison of performance after Secondary Treatment of major technologies (Tare V., 2010)

S. No	Parameter	Technology					
		ASP	MBBR	SBR	UASB+ EA	MBR	WSP
1.	Effluent BOD, mg/l	< 20	< 20	< 10	< 20	< 5	< 40
2.	Effluent SS, mg/l	< 30	< 30	< 10	< 30	< 5	< 100
3.	Faecal Coliform removal, log unit	Upto 2<3	Upto 2<3	Upto 3<4	Upto 2<3	Upto 5<6	Upto 2<3
4.	T-N Removal efficiency, %	10-20	10-20	70-80	10-20	70-80	10-20

The study of performance evaluation of different Technologies used in Sewage Treatment Plant shows STP designed on MBR Technology results in maximum removal of BOD and SS with the value less than 5 mg/l. This is followed by SBR Technology which results in reduction of BOD and SS level to the value less than 10 mg/l. Maximum removal of Faecal Coliform is achieved by MBR Technology which is in the range of 5-6 log unit and is followed by SBR Technology which can remove Faecal Coliform upto the range of 3-4 log unit. Maximum T-N removal efficiency is found in SBR and MBR Technology having value of 70-80% whereas other Technologies ASP, MBBR, UASB and WSP shows removal efficiency of 10-20%. WSP has the least water effluent quality. Therefore, STPs based on MBR and SBR technologies are predominant.

Table 3: Comparison of area requirement and treatment costs of various technologies for STP (Tare V., 2010)

S. No	Parameter	Technology					
		ASP	**MBBR**	**SBR**	**UASB+ EA**	**MBR**	**WSP**
	Average Area, m^2 per MLD	900	450	450	1000	450	6000
	Average Capital Cost, *lacs/MLD*	68	68	75	68	300	23
	Civil Works, % of total capital costs	60	60	30	65	20	90
	E&M Works, % of total capital costs	40	40	70	35	80	10

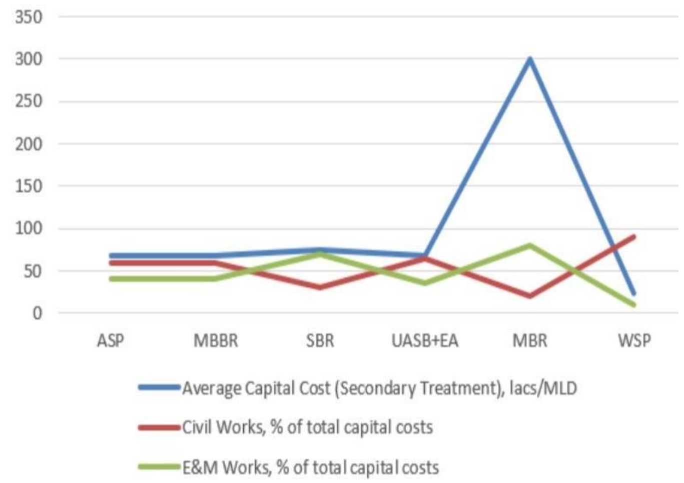

Chart -4: Comparison of treatment costs of various technologies for STP

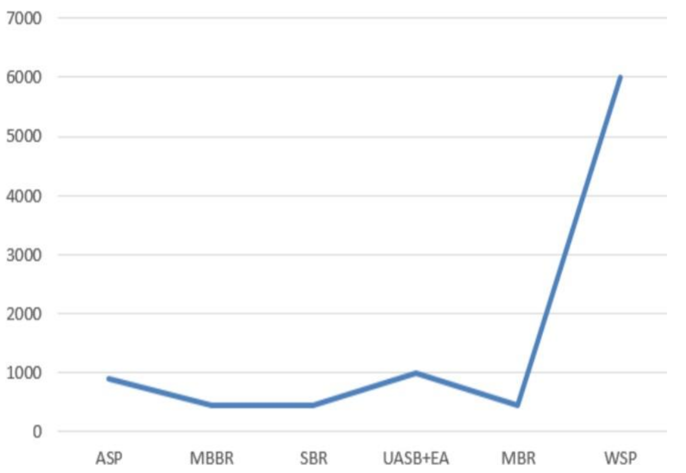

Chart -5: Comparison of area requirements of various technologies for STP

Based on the data analysis and from above Chart-4, it is observed that average capital cost of STP based on MBR Technology is 300 lacs per MLD. Thus, making it undesirable. Secondly, it can also be seen that WSP requires civil works equal to 90% of total capital costs and ASP, MBBR, UASB requires almost 60-65% of total costs. The civil works for STP based on SBR Technology involves 30% of total costs whereas MBR Technology requires 20% of total costs. Thus, STP based on SBR or MBBR technology are found to be desirable. However, cost for E&M Works for STPs designed on WSP Technology is very less i.e., 10% of total costs and is followed by UASB+ EA with 35% of total costs. ASP and MBBR requires 40% of total costs whereas SBR Technology requires 70% of total costs which is almost at par with MBR Technology requiring 80% of total costs.

From Chart-5, it is understood that an average area of about 6000 m2 per MLD is required for construction of STP in case of WSP Technology, which is too high. Whereas MBBR, SBR and MBR Technology requires the minimal footprint of the treatment plant i.e., 450 m2 per MLD followed by ASP and UASB+EA requiring 900 and 1000 m2 per MLD respectively.

Table 4: Comparison of Operation & Maintenance cost of various technologies for STP (Tare V., 2010)

S. No	**Parameter**	**Technology**					
		ASP	**MBBR**	**SBR**	**UASB+EA**	**MBR**	**WSP**
1.	**Energy cost (per MLD)**						
1.1.	Avg. Technology Power requirement, kWh/d/MLD	180	220	150	120	300	2.00
1.2	Avg. Technology Power requirement, kWh/d/MLD	4.5	2.50	2.50	4.50	2.50	2.50
1.3	Total Daily Power Requirement (avg) kWh/d/MLD	184.50	222.50	152.50	124.50	301.50	4.50
1.4	Daily Power Cost *(@6.0 per kWh)/MLD/h (including, standby power cost)*	46.43	55.93	38.43	31.43	75.93	1.43
1.5	Yearly Power cost, *lacs pa/MLD*	4.07	4.90	3.37	2.75	6.65	0.49
2.	**Repairs Cost (Per MLD)**						
2.1	Civil works Maintenance, *lacs pa/MLD*	1.94	1.30	1.04	2.11	-	1.70
2.2	E&M Works Maintenance, *lacs pa/MLD*	0.43	0.65	0.81	0.38	-	0.06
2.3	Annual repair Costs, lacs *pa/MLD*	2.37	1.95	1.85	2.49	-	1.76

From Chart -6 it is understood that cost of energy per MLD to run the plant is least with WSP Technology i.e only 0.49 lacs per year per MLD whereas maximum cost is incurred i.e. 6.65 lacs per year per MLD with MBR Technology. Energy cost to run the plant is quite reasonable when STPs are designed on SBR Technology (3.37 lacs per year per MLD) and UASB+ EA Technology (2.75 per year per MLD). For SBR technology, repair cost is 1.85 lacs per year per MLD whereas for ASP and UASB technologies based STPs is nearly equal to 2.37 and 2.49 lacs per year per MLD respectively.

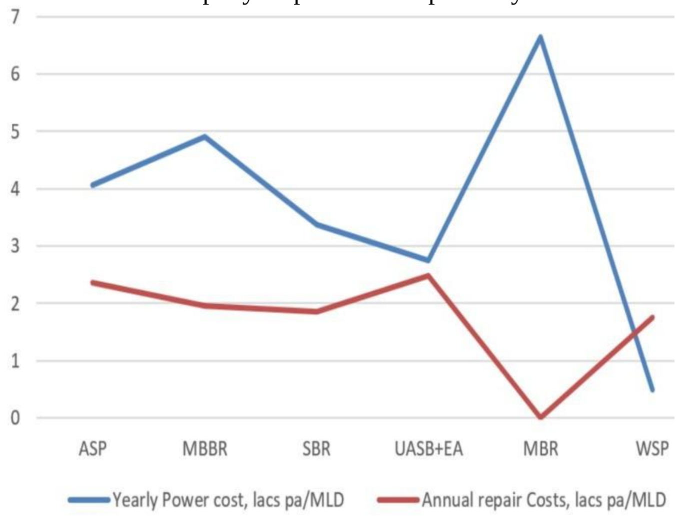

Chart -6: Comparison of O&M cost of various technologies for STPs

7. CRITERIA FOR SELECTION OF AN APPROPRIATE TREATMENT TECHNOLOGY FOR STP

Besides treatment costs, the selection of a treatment technology must be based on the analysis of all key parameters as discussed, then evaluated and weighed against alternative technologies to reach to a final recommendation. The various technologies are assessed and ranked as Low, Medium, High and Very High and is exhibited in Table 5.

Table 5: Criteria for selection of an Appropriate Treatment Technology for STP

S. No	Criteria	Technology					
		ASP	MBBR	SBR	UASB + EA	MBR	WSP
1.	Removal of BOD, COD, TSS	High	Very High	Very High	High	Very High	Medium
2.	Faecal Coliform Removal	High	Very High	Very High	High	Very High	Low
3.	Nitrogen Removal	Low	Medium	Very High	Low	Medium	Low
4.	Phosphorous removal	Low	Medium	Very High	Low	Medium	Low
5.	Area Requirement	High	Medium	Medium	High	Low	Very High
6.	Energy Requirement	High	High	Medium	Medium	Very High	Low
7.	Capital Cost	Medium	Medium	Medium	Medium	Very High	Low
8.	Repair Cost	High	Medium	Medium	High	Medium	Low
9.	Skill Requirement	High	Medium	High	Medium	Very High	Low

8. CONCLUSIONS

From the above study, it can be concluded that Stabilization Pond and UASB are not applicable because they cannot give the desired treated water quality. Moreover, Activated Sludge process and Moving Bed Bio Reactor process (MBBR) can produce treated water quality but it requires downstream filtration. The overall system becomes expensive from capital and operation point of view. Membrane reactor produces effluent of better quality. However, the running and capital cost for plant based on MBR is extremely high. Thus, on the basis of above study and major factors such as high performance, low area requirement and low capital cost SBR technology is chosen as the most appropriate technology. SBR Technology can produce the desired quality of treated water.

REFERENCES

[1] Crawford G. (2010)," Technology Roadmap for Sustainable Wastewater Treatment Plants in a Carbon - Constrained World",
WERF Report Series

[2] Jhansi, Mishra S.C (2013)," Wastewater Treatment and Reuse: Sustainability Options", Journal of Sustainability Development, 10(1),1-15.

[3] Manual on sewerage and Sewage Treatment System (2013), Ministry of Urban Development, New Delhi, CPHEEO.

[4] Meena S. D (2021)," National Inventory of Sewage Treatment Plants (2021)", Central Pollution Control Board, 17-20, www.cpcb.nic.in

[5] Metcalf and Eddy Inc., (2003), "Wastewater Engineering-Treatment, Disposal and Reuse", 4th Edition, Tata McGraw Hill Publisher Co. Ltd., New Delhi.

[6] Tare V. (2010), "Sewage Treatment in Class I Towns: Recommendations and Guidelines", Report (Code 003-GBP-IIT-EQP-S&R-O2-Ver1)

[7] Wongburi P. et. al (2018)," Decision making tools for selecting sustainable wastewater treatment technologies in Thailand", Earth and Environmental Science, Volume 150, Issue 1, pp. 012013 .

