



ALLEVIATING THE FIRE HAZARD AND SUSTAINABILITY IN THE HINDU KUSH HIMALAYA REGION IN INDIA

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Introduction

- The Indian Himalayan Region (IHR) covers nearly 18.15% geographical area of India and 30.79% forest area of the total forest cover of India [1].
- On an average 4000 fires incident per year has been experienced by this region and the total black carbon emissions in the Indian Himalayan region are around 431 Mg per year due to natural fire hazards [2].
- During the forest fire season 2019-2020 in the IHR, almost 162232.3 hectares of forest area have been severely impacted by wildfires. In this territory, a total of 122,200 forest fires points have been observed over a 13-year span [3].
- According to the Biomass Resources Atlas of India, Indian Institute of Science, this region generates annually about 40 million tonnes of forest biomass (or residues) and 27 million tonnes of forest biomass surplus [4].
- The map of study site is given below [5]:

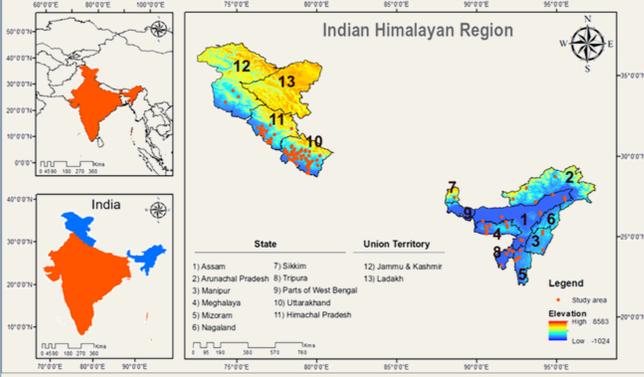
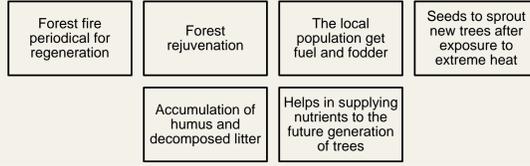


Table 1: Forest Cover Area of IHR's states under different Fire-Prone Classes [3]

State	Extreme Fire-Prone		Highly Fire-Prone		Fire-Prone		Moderately Fire-Prone		Less Fire-Prone	
	Forest cover area (km ²)	% of total forest cover	Forest cover area (km ²)	% of total forest cover	Forest cover area (km ²)	% of total forest cover	Forest cover area (km ²)	% of total forest cover	Forest cover area (km ²)	% of total forest cover
Arunachal Pradesh	13.00	0.02	648.00	0.97	2334.00	3.49	4598.00	6.87	59371.00	88.65
Assam	5493.00	21.98	1522.00	6.10	3619.00	14.48	3428.00	13.72	10923.00	43.72
Himachal Pradesh	0.00	0.00	4.00	0.03	172.00	1.18	670.00	4.59	13748.00	94.20
Jammu & Kashmir	0.00	0.00	18.00	0.08	84.00	0.38	584.00	2.65	21355.00	96.89
Manipur	769.00	4.48	5755.00	33.13	6219.00	35.85	2665.00	15.36	1937.00	11.18
Meghalaya	983.00	5.74	3152.00	18.38	3452.00	20.13	3047.00	17.77	6512.00	37.98
Mizoram	5423.00	29.91	7009.00	38.46	4481.00	24.64	972.00	5.35	299.00	1.64
Nagaland	380.00	3.05	2309.00	18.48	4752.00	38.05	3204.00	25.65	1844.00	14.77
Sikkim	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3213.00	100.00
Tripura	1862.00	26.95	1555.00	21.90	881.00	12.62	751.00	10.76	1939.00	27.77
Uttarakhand	40.00	0.17	389.00	1.60	2254.00	9.32	5238.00	21.66	16264.00	67.25
West Bengal	0	0	82	0.99	360	4.33	892	10.72	6988	83.96

Benefits of fire hazard

Fire hazards are always taken as negative impact on to ecosystem, but it is not true every time. Globally around 46% of all eco-regions are dependent on or influenced by fire. These regions have fire as an integral part sustaining of natural fauna and flora [6].



Impacts of fire hazard

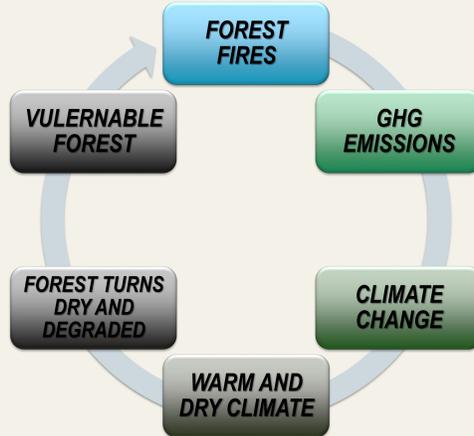
Environmental and economical impact [6]

- In 2015, the U.S. experienced one of the worst fires, making the region lose 4.1 million ha of forest.
- Indonesia lost 27.5 million ha of forest due to fires, logging and conversion to other products since 1990 and still counting.
- In Germany, 1.8 million euros are lost on average annually from 1991 to 2014 to protect forests
- The amount is spent to protect the control of fire in the prone areas.

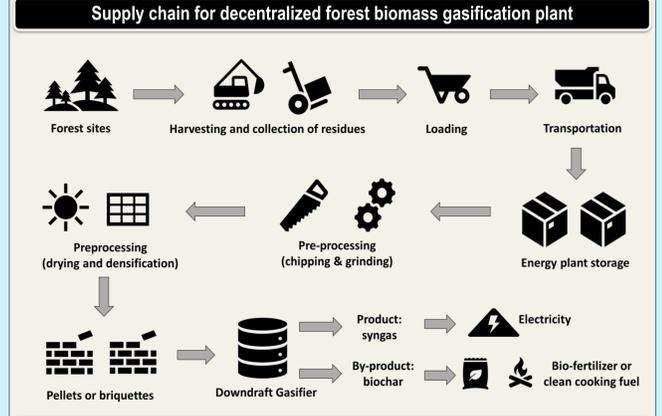
Climate impact [6]

- Globally around 15-20% of annual carbon emissions are added to the atmosphere due to forest degradation and destruction.
- The number and scale of fires increase, thereby creating a positive feedback loop
- forest fires in Savannah release 1.7 to annually release 1.7 to 4.1 billion t of carbon dioxide into the atmosphere
- 15 % of the global GHG emissions are attributed to forest fires

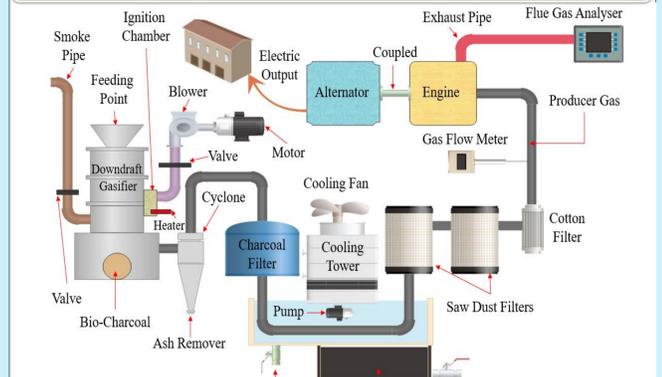
Positive feedback loop



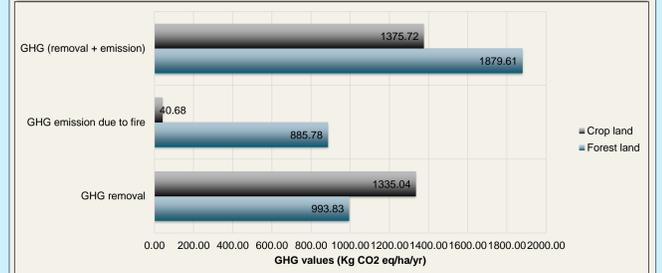
Curbing fire hazard: Proposed solution



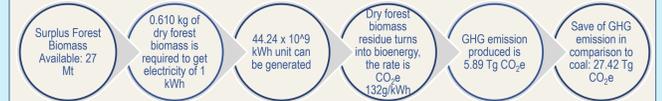
Flow diagram of decentralized downdraft gasifier system for electricity generation



GHG emission [8,9,10]

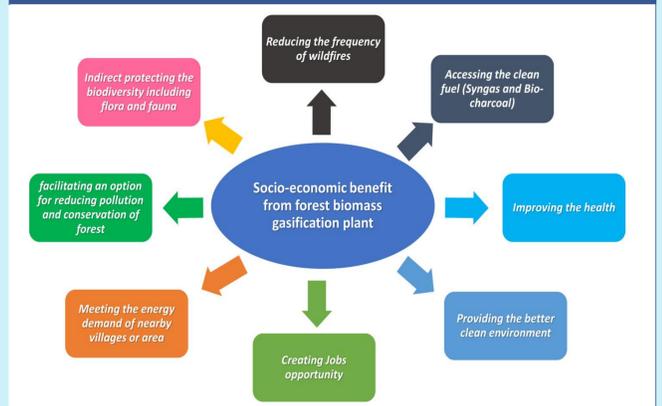


GHG emission caused due to wildfire will be approximately 1375.72 Kg CO₂ eq/ha/yr in case of Crop land whereas 1879.01 Kg CO₂ eq/ha/yr in case of forest land. This GHG emission is summation of GHG removal which was suppose to be done by the forest/crop land and GHG emission due to fire.



GHG emission saved while using biomass found in IHR forest as electricity source in place of coal is around 27.42 Tg CO₂ eq

Conclusions



Acknowledgements

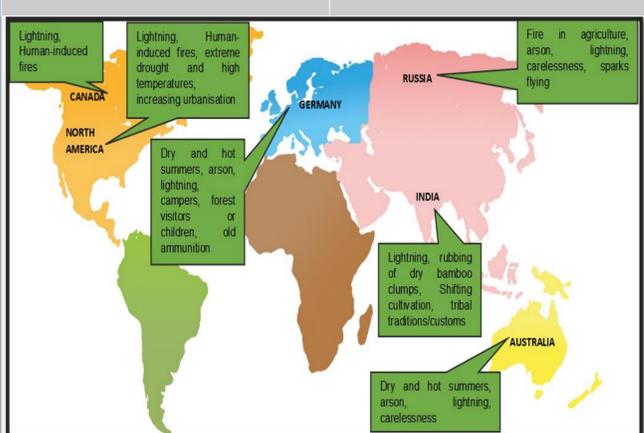
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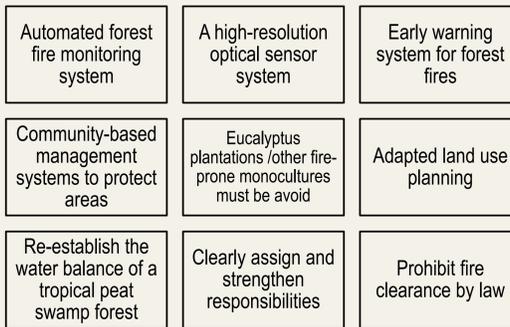
Causes of fire hazards

Anthropogenic Causes	Natural Causes
<ul style="list-style-type: none"> Arson Carelessness Ammunition Shifting cultivation Tribal traditions/customs To have good growth of grass Tendu leaves and fodder To clear the path by villagers Due to rivalry To encroach upon the forest land 	<ul style="list-style-type: none"> Storms Drought High temperatures Lightning Volcanic eruptions Rubbing of dry bamboo clumps The friction of rolling stone



Curbing of fire hazard: Existing solutions

PREVENTION IS BETTER THAN CURE



In India, Forest floor biomass management is been proposed as a part [7]:

- Collection of forest floor biomass such as fallen pine needles for use in briquettes may be encouraged by the royalty and transit fee waiver for such collections.
- Policies for promoting biomass-based off-grid micropower plants in remote areas may be put in place. Space heating in high altitude areas could be tried using excess biomass from forest floors vulnerable to fires.
- Guidelines may be framed for the sustainable removal of dead bamboo in the event of mass flowering to reduce the risk of fire and conserve biodiversity.
- Policies for permitting women Self help groups (SHG) to use forest floor biomass with appropriate safeguards for micro-entrepreneurship may be put in place by the SFDs

Challenges associated with Forest Biomass

