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Program/Course	**:**	**MA Economics (EE)**					
Semester	**:**	**IV**					
Name of the Subject	**:**	**Energy and Climate Change**					
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Name of Question Paper Setter	**:**	**Dr. Narendra Nath Dalei**					
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UNIVERSITY OF PETROLEUM & ENERGY STUDIES

DEHRADUN

End Semester Examination-April 2018

Program/course: MA Economics (Energy Economics)	**Semester : IV**
Subject: Energy and Climate Change	**Max. Marks : 100**
Code : OGET 8008	**Duration : 3 Hrs**
No. of page/s: 13	

Section-A

Q1. Write short notes on the following 2 X10= 20

i. Global warming
ii. Stranded Assets
iii. Solar Energy
iv. Impact of climate change
v. Climate change adaptation
vi. International Climate Change Negotiations
vii. Wind energy
viii. Carbon capture and storage
ix. COP 21
x. INDC

Section-B

Answer any four questions 5 X4= 20

Q2. Explain critically energy environmental interaction at global level.

Q3. What is carbon budget? Describe in context of Paris Agreement.

Q4. Explain Green House Effect in context of Global Warming.

Q5. What is decarbonization? How we can achieve deep decarbonization?

Q6. "Countries that have crude oil reserves, and especially companies that have those reserves, are not too happy about deep decarbonization." Critically examine the statement.

Section C

Q7. Read the following case study and answer only two questions given at the end of the case study: 2 X 15 = 30

FOREST FIRE IN INDIAN STATE OF UTTARAKHAND

Forest fire has been a common phenomenon and will continue to increase more frequently than the recent past due to impact of rising temperature and global warming. Climate-related stress and secondary stressors on forests (e.g., insect and disease, fire) have dramatically increased since the turn of the century globally, while harvest rates in the western US and elsewhere have declined (Cohen, et al., 2016). There has been a decline of forest areas of the world by more than 129 million hectare. While around 35% of remainder is primary forest, secondary forests are therefore relatively more important for biodiversity conservation, catchment protection, climate control, and the ecological services they provide (Abbas, Nichol, & Fischer, 2016). The area of global forests according to Birdsey & Pan (2015) has declined by 3% since 1990 but the area of planted forest has increased in all regions of the world and now accounts for almost 7% of global forest land. In view of this forest fire has been considered as a serious problem, threating the ecology and biodiversity. It has been observed since pre-historic period that forest fire occurs mainly due to lightening and in Indian context the probability of occurrences due to lightening is very less as compared to anthropogenic occurrence. Thus, most of the forest fire in India including Uttarakhand is manmade and the reason for it is yet to be explored. People here in Uttarakhand may have their vested interest of getting short term benefit out of forest fire, whereas the long term repercussion is not known to them. They are the common man with their habitat in the vicinity of forest and may have extracted a part of their daily livelihood from forest. To what extent they are depending upon forest is also yet to be explored. However, rising temperature helps in catching the fire at a rapid pace once someone put the fire in the forest.

Forest Fire in Uttarakhand

Incidence of forest fire this year has been very bad and in Uttarakhand it was worse than ever. Fire smashed nearly 4,000 hectare of forest cover across 13 districts and killed 9 and injured 17 people along with damaging biodiversity and forest ecosystems very significantly. The frequency of forest fire in Uttarakhand during April 2016 was much higher and widespread than during April 2015 as shown in Table 1.

Table 1 and Fig. 1 show that during April 2015, forest fire points were identified only in two districts viz. Nainital and Udham Singh Nagar with 1 and 6 fire points respectively, whereas during same period of current year forest fire spread over 13 district with a maximum number of fire points observed in Pauri Garhwal followed by Nainital. Thus around 32% of the total 1270 fire points were observed in Pauri Garhwal followed by around 22% in Nainital during April of the current year.

Table1: Frequency of Fire Points of Uttarakhand Forest during April 2015 and April 2016

Sl. No.	District	Apr-15			Apr-16		
		Freq.	Percent	Cum.	Freq.	Percent	Cum.
1	Almora	0	0	0	89	7.01	7.01
2	Bageshwar	0	0	0	42	3.31	10.31
3	Chamoli	0	0	0	52	4.09	14.41

4	Champawat	0	0	0	62	4.88	19.29
5	Dehradun	0	0	0	77	6.06	25.35
6	Haridwar	0	0	0	91	7.17	32.52
7	Nainital	1	14.29	14.29	276	21.73	54.25
8	Pauri Garhwal	0	0	0	402	31.65	85.91
9	Pithoragarh	0	0	0	17	1.34	87.24
10	Rudraprayag	0	0	0	1	0.08	87.32
11	Tehri Garhwal	0	0	0	134	10.55	97.87
12	Udham Singh Nagar	6	85.71	100	20	1.57	99.45
13	Uttarkashi	0			7	0.55	100
	Total	7	100		1,270	100	

Source: Compiled by author from Forest Survey of India web site (Accessed on 8th May 2016)

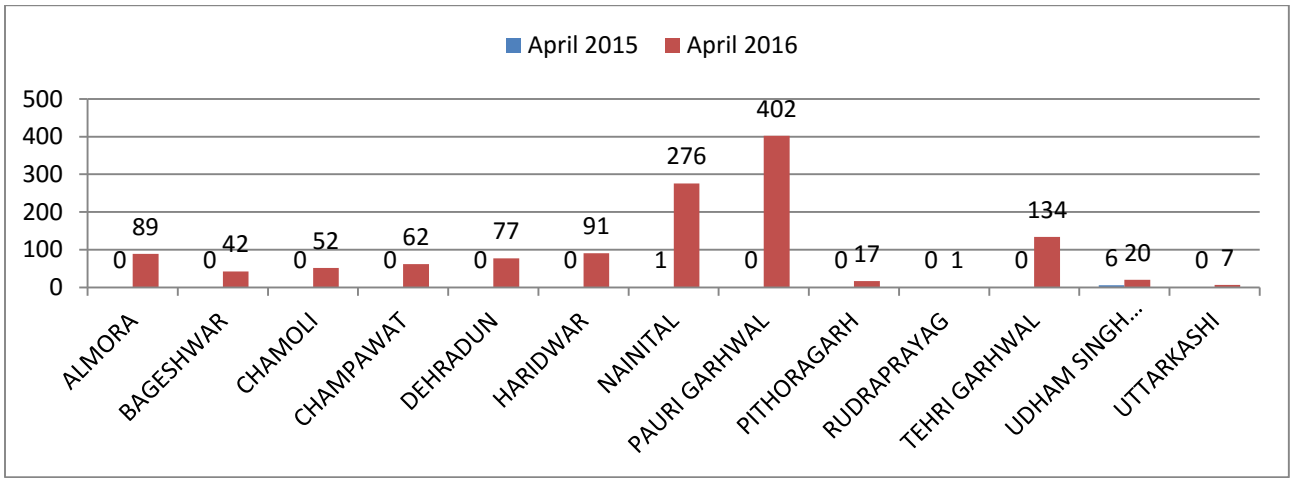


Fig.1: Frequency of Fire Points of Uttarakhand Forest during April 2015 and April 2016
Source: Compiled by author from Forest Survey of India web site (Accessed on 8th May 2016)

What Causes Forest Fire?

Environmental and climate scientist are of the view that high temperatures, no atmospheric moisture and no rainfall were the major reason for current year's forest fires. Some of the scientists also believe that abridged precipitation during summer season have a moisture reduction impact on woods and bushes causing the humidity level to go down at ground level, allowing fire to catch more rapidly and spread quickly over the forest land. Scientists also believe that El Nino may have some significant role in forest fire. Due to climate change surface air temperature increases significantly which may have significant interaction with El Nino causing fire to spread across the forest. Dry weather with increase of vapour pressure deficit near the surface due to rising temperature can also help in drying woods and bushes more rapidly than in normal situation allowing fires to catch and spread more rapidly and quickly beyond human control.

Fig. 2: Forest Fire in Uttarakhand

Thus dry weather, low seasonal rain and vapour pressure deficit followed by burning of pine needles, burning of litter and shading of plants by local people and unsustainable forest conservation policy are all responsible for forest fire in Uttarakhand.

Damages due to Forest Fire in Uttarakhand

Forest fires in Uttarakhand have affected 13 districts with loss of many human and animal lives. Table 1, Fig.1 and Fig. 2 show that Pauri Garhwal, Nainital and Tehri Garhwal out of 13 affected district were most impacted by the fire. Ecologist and environmental scientist are of the view that Himalayan glaciers have been affected severely by the Uttarakhand forest fire. Black carbon deposit in the glaciers from smoke and ash of forest fire which is having high temperature absorbing capacity will cause ice to melt faster. This will create ecological imbalance with negative impact and disaster in the region in near future. The glaciers are feeding the rivers in Northern India, which will now carry harmful chemicals and pollutions due to such carbon deposits. Besides much human loss, flora, fauna and wild animal losses were also significantly observed during the two months of forest fire. Around 10,000 people of state and central government officials and residents were deployed to douse the fire. The damage to biodiversity with loss of flora, fauna, and bird species were significantly high than larger animals such as tigers, deer and elephants, who manage to escape to safer places. Besides, tourism is also very badly affected by this forest fire.

Forest Fire: Lesson from rest of the World

Even with large expenditures and substantial infrastructure dedicated to fire suppression, the annual area burned by wildfire has increased over the last decade. Reducing annual area burned in the western United States will require long-term coordinated efforts by federal and state governments, with robust partnerships between land-management agencies and the public in collaborative planning and stewardship (Stephens & Ruth, 2004).

The Canadian Wildland Fire Strategy Assistant Deputy Ministers Task Group (2005) have a view that a new approach to wildland fire management in Canada will require changes in the attitudes and actions of individuals, stakeholder groups, the private sector, and governments. The underlying tenet is that managing the risks from wildland fire is a shared responsibility needing integrated and co-operative actions. Studying the forest fire suppression in the United States, Berry (2007) opined that as long as there is a blank check for emergency fire suppression, most fires will be suppressed and wildland fire use will be limited. She has a view that there is no simple solution to remedy the problems of fire policy. Ecosystems are diverse and constantly changing. Fire's role is not the same across all landscapes or to all species. Therefore, a successful fire policy should incorporate a greater degree of local control.

The agricultural activities in the forest periphery constitute a potential ignition source (debris and field burning, etc.). It is thus necessary to limit the risk of a fire spread towards the forest and to reduce the combustible biomass in periphery of the forests (FAO, 1993). The causes of forest fires according to Mateus & Fernandes (2016) are manifold and in Portugal, as elsewhere in Europe, are essentially anthropogenic. Three pillars of action according to them to suppress fire are considered, each coordinated by a distinct agency: structural prevention; vigilance, fire detection and law enforcement; and fire suppression. The British Columbia Wildland Fire Management Strategy provides direction for a proactive wildland fire management program. Full strategy implementation will result in reduced wildfire impacts and smoke risks to communities and infrastructure, healthy and resilient ecosystems, broad public support for proactive fire management and a more cost-effective fire response program for the province of British Columbia (BRITISH COLUMBIA, 2010).

Conclusion

Forest fire has been a local issue with global impact, which will continue to increase more frequently than the recent past due to impact of rising temperature and global warming. Most of the forest fires in Indian state of Uttarakhand are anthropogenic in nature. Around 32% of the total 1270 fire points were detected in Pauri Garhwal followed by around 22% in Nainital during April of the current year. Thus forest of Uttarakhand has been very badly affected by the current year forest fire with a significant impact on forest ecology, natural biodiversity and Himalayan glaciers. Extreme dry weather, low seasonal rain and vapour pressure deficit followed by burning of pine needles, burning of litter and shading of plants by local people and unsustainable forest conservation policy are all responsible for forest fire in Uttarakhand.

Changes in the attitudes and actions of individuals, stakeholder groups, the private sector, and governments are required for action and implementation of sustainable forest fire prevention policies. Thus management of the risks from forest fire is a coordinated shared responsibility needing integrated and co-operative actions. There should be blank check for emergency fire suppression to suppres forest fires. A successful fire policy should incorporate a greater degree of local control. Limiting the risk of a fire spread towards the forest and reducing the combustible biomass in periphery of the forests will help in controlling forest fire to a larger extent. Structural prevention; vigilance, fire detection and law enforcement; and fire suppression are three pillars of action to be adopted to suppress forest fire. Thus prevention of forest fire will require long-term coordinated efforts by public and private authorities with robust planning and informed policy implementation.

Answer only two of the following questions:

(a) What do you understand by forest fire? Examine its causes and consequences in Uttarakhand? (15)

(b) What are the lessons available in the case study to mitigate forest fires in Uttarakhand? (15)

(c) Why long-term coordinated efforts by public and private authorities with robust planning and informed policy implementation is needed to mitigate forest fires in Indian state of Uttarakhand? (15)

Section D

Answer only one question 1 X 30 = 30

Q8. Read the following case study and answer questions given at the end of the case study:

Deep Decarbonization: The Three Pillars and National Case Studies
Case Study: Russia Deep Decarbonization

Everybody knows that Russia is a huge country. By territory, Russia plays very important role in global ecological systems; of course, it plays significant role in climate change issues.

One of the focuses of research for the last twenty years already is low-carbon development for Russia. It is a very challenging issue, of course. Russia has huge reserves of fossil fuels-oil, gas, coal, shale gas and oil, and other resources-but, on the other hand, Russia has also carbon-free sources of energy and many other technologies and resources available for climate-friendly development in this century.

Russia got a very important and serious task through Deep Decarbonization Project:
Can we see, can we model Russian economy being climate-friendly, targeting to well-below 2 C degrees goal that we now have in the Paris Climate Agreement?

It is, of course, challenging. Russia needs a lot of CO2 and other greenhouse gases from energy sector, from transport, industries, waste and landfill, and forestry. The climate science is not a top-priority for Russian people, for Russian government, for Russian business, it is evident. As well as many environmental challenges are not on top of priorities, but over time, perception of the issue is changing. So we should say that after ratification of Kyoto protocol, by now, more and more people feel changes and impetus on themselves, on the economy, environment where they live.

As we remember, according to last surveys, about 80% of Russians understand and consider climate change as a threat. It has different impacts in different regions of Russian provinces, but they consider this as an important challenge. Does it affect decision-making? We are not sure; sometimes, yes.

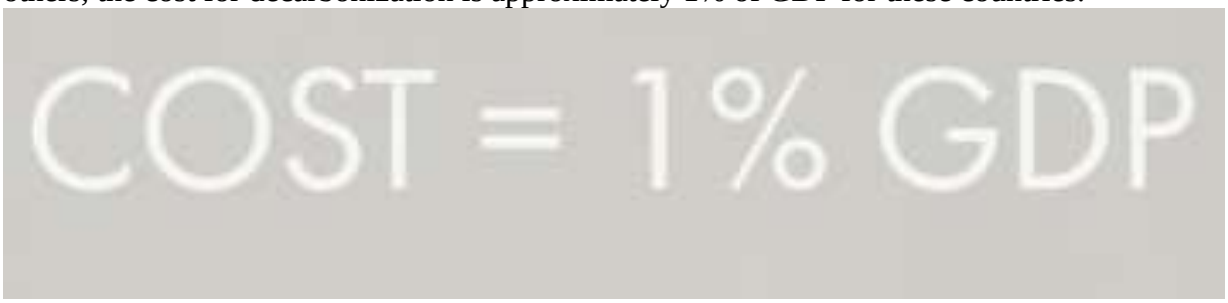
So if you have flooding in the Russian far-east, and moreover, and thousands of people lost their houses, this is a problem. If you have heatwave in Moscow and the central-European Russia, and thousands of people dying, it is a problem. It is sharp perception of what is going on. Same about forest fires. Same about droughts and loss of crop.

So, we have to find the ways how we can change Russian economy so that we would reduce emissions almost to zero by mid-century. So, what we did was we modeled a few scenarios, looking at different technological options to reduce emissions in Russia. We actually found a few pathways that we can do this significant reduction of carbon emissions.

Specifically, our target was about 87% emission reduction by 2050, mostly of CO2 emissions, but we also focused on other sectors. We have modeled solutions, model pathways, and now we see how difficult it is to integrate this scientific research results into our agenda for policy-makers.

What we can propose, of course, is that we definitely need to include in the current decision-making technological options and risks and opportunities related to use of different energy sources, for instance. We considered different approaches, and we found that plenty of resources and technologies are available for using green energy rather than fossil fuels, including solar PV, wind, huge tidal power plants that could be installed in the far-east of Russia, in the northwest of Russia; it is related to bio-energy resources, to geothermal, so we did an analysis of investment costs and current costs, and we found that, actually, following the pathway of deep decarbonization for Russia is not really costly.

We decided to compare this result with other countries involved in this decarbonization project, and surprisingly, we found out that other countries have similar results. And overall picture for 16 largest emitting countries in the world, including US, China, India, Russia, Japan, Canada and others, the cost for decarbonization is approximately 1% of GDP for these countries.



So we found out that we do have interesting elements of this long-term story by 2050, cost-reduction for many technologies- especially, renewable energy sources-appearance of new technologies that we might expect, say by 2030, cheaper technologies for carbon capture and storage, options so we see this way of reducing costs.

Another part of the story is that we may include in decision-making green options now so that when we substitute outdated technologies in time by new carbon-free technologies, it saves a lot of money for us. So, we concluded that it is fairly reasonable to invest and start policy-making related to low-carbon development in the country. But, we also found out that we have at least two additional strong options for emission reduction. One relates to basic materials. Maybe not many people know that approximately 28% of global emissions are linked with basic materials production and use. So this includes cement, metals, rubber, plastics, and others and we do have in Russia technologies relating to significantly reduce carbon footprint of basic materials.

Another interesting point is forests. Russia is rich of forests, we have huge part of global forests, and this forest is boreal. The boreal forest plays different role than tropical forest, actually, so our forest breathes in carbon dioxide, and keep it-store it-for many decades. So we need to care about this source of sequestration of carbon from atmosphere. And here we have challenges. Russian forest is getting older. We face impetus of climate change so that forest fires appear more often at higher scale, so we need to take measures to keep capacity of Russian forests to absorb carbon.

So this is another challenge we faced in our research. So it's not easy to say, okay, Russia will absorb a lot of carbon because of forest so we don't do anything about emission reduction. So this is the wrong position. We need to do both; reduce emissions, and keep and enhance sequestration. It is challenging. At least by mid-century, it is a task for us.

Also, we found very interesting inter-regional issue, for instance, in Asian part of Russia and neighboring countries, including Korea, China, Japan, Mongolia, we can see opportunities for cooperation in using huge potential for green energy. So these sources of energy would account for about a few hundred gigawatts of installed capacity potentially, including solar, wind, tidal, bio-energy, hydro, so this could play important role for decarbonization of neighboring countries as well, including China, which is a big challenge for all of us, for all globe.

When we discuss what can we do in practice, we definitely should see the whole picture. The picture today for Russia is not just improving slightly energy efficiency or including more percents of renewables; it is a bigger challenge. It is a task to reach net-zero emissions. In this task, the whole story becomes absolutely different. So we have to do plenty of things nowadays to integrate in strategic planning, in business plans of corporations this switch towards huge scale implementations of carbon-free technologies. It is challenging. It is not costly. It is possible.

All projects that we have on energy-efficiency, on renewable energy improves quality of environment, air quality, reduces health risks, improves sustainability of the regional development, so this is multi-task, multi-dimensional story, not just carbon story.

Russia will take the lead in this, because we have huge opportunities for renewable energy and technology options aiming at reduction of carbon emissions dramatically, over 80-90%. But it is not easy. For Russia, it's important to see that Russia is not alone. That Russia is doing as much as the others; as US is doing, as China is trying to do. And of course, cooperation will play important role. Cooperation not in fossil fuels, cooperation in low carbon technologies or in zero-carbon technologies in transport, in energy systems, in many areas where we see emissions.

There are some priority issues, of course, for Russia. Improving of infrastructure, improving of communal heating, energy systems, rearrangement of energy systems in favor of low-carbon technologies, but this is possible to do. And what we see from experience of other countries, when you have strategy for national scale, you will see option for sub-national schemes, some that show efforts. And this is very impressive experience that we can already see in Canada, for instance-in case of Alberta adopting decarbonization strategies on province level-we may see similar things in China, specifically regarding province-based initial trading schemes. We should cooperate, we see and we find ways to do it, and I'm pretty sure it is for all of us to find appropriate ways.

Paris Agreement plays important role, but not only Agreement is important for it, so we need to find bilateral, multi-lateral mechanisms to do so. We may see them in BRICS agenda, we may see them in other cooperative platforms, and among countries, but Russia may be important player in this field and support the others, in terms of inventions, technologies, resources.
Now, we see reality, and reality is sometimes different. It is different in many countries, not only Russia. When lobbyists from fossil fuels play more important role than lobbyists of renewable energy, for instance. So this administrative, this economic financial incentives, are to be resolved; these issues are very important of course. So, Russian policy-makers and businesses should see three processes in order to make decisions faster and stronger. First, the decarbonization is really important and is practical for other big plans, including China, US, India, Brazil, Europe.

So this is a concept, but not scientific concept. This is a practical thing for development; planning cooperation from others. Second, extremely important. We should see divestment from fossil fuels and we already see some process-not everybody believes that this is real-but the scale of it already reached over three trillion US dollars in value of assets divested from fossil fuels.

It is very important for Russian stakeholders, for Russian stockholders, for Russian businesses to feel that okay, so if you do nothing, you are at risk. That investors will face a problem financing the projects. So this is, urgent, very important educator for Russian businesses and policy-makers to switch faster.
The third important element would be carbon pricing. So if you don't see carbon pricing in broader than dimension like it is high, the price for carbon, and it is everywhere, at least in the markets that Russian companies operate in.

If we see this-say, if the price is $15 dollars a ton, or 30 Euro a ton, as in France-this would change the rules of the game. Change economics of projects and regional development. So if we see these three processes moving on, enhancing, over time, it would definitely change the understanding and efforts in Russia.

Answer all the questions:

a) Why is decarbonization challenging for Russia? (10)

b) Can we model Russian economy being climate-friendly, targeting to well-below 2^0C goal that we have in the Paris Climate Agreement? Examine critically. (20)