The Environment and Sustainability Anthology

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Preface:

This anthology presents seven research reports examining topics about the environment and sustainability, ranging from biodiversity and ecosystems to waste management and environmental policy. Each report provides unique insights into challenges facing our planet and practical approaches to solving them.

Through research and advocacy, these articles underscore the urgent need for collective action in addressing environmental degradation. They explore diverse perspectives about environmental problems and inspire positive change in your communities and beyond.

To everyone reading this anthology, I hope you have as much fun as I had writing each feature article in here!

The Three Gorges Dam: The Dream of Every Chinese Leader

Introduction:

The Three Gorges Dam is a hydroelectric gravity dam that spans the Yangtze River (Chang Jiang) by the town of Sandouping, in Yiling District, Yichang, Hubei province, central China, downstream of the Three Gorges. The Dam is an awe-inspiring structure which is one of the few man-made structures on Earth that's visible to the naked eye from space, according to NASA.

When construction of the dam officially began in 1994, it was the largest engineering project in China. At the time of its completion in 2006, it was the largest dam structure in the world. The dam and accompanying hydroelectric plant were built in phases and over the course of many years. It reached its full generating capacity as of July 4, 2012, when the last of the main water turbines in the underground plant began production. The last major component of the project, the ship lift, was completed in December 2015.

The Three Gorges Dam has been the world's largest power station in terms of installed capacity since 2012. The Three Gorge dam produces enough energy to light up Boston, New York City, and Washington DC combined and it covers 10% of China’s energy use.

As well as producing electricity, the dam is intended to increase the Yangtze River's shipping capacity. The dam allows the navigation of ocean going freighters. It was also intended to provide protection from floods. By providing flood storage space, the dam reduces the potential for floods downstream which have historically plagued the Yangtze Plain.

However, its efficacy on this point is unclear and has been debated. While officials say that the dam reduces damage and loss of life from the floods, critics assert that the heavy floods of 2010 and 2020 served to highlight the limitations of the dam as an effective flood-control tool.

China regards the project as a monumental social and economical success, with the design of state-of-the-art large turbines, and a move toward limiting greenhouse gas emissions. However, the dam has caused several changes, especially ecological ones including an increased risk of

landslides. Because of the same reason, the dam has been controversial both domestically and abroad.

This case study provides an outlook on the Three Gorges Dam, a development project that turned heads from around the world.

History:

The Chinese have for millennia manipulated waterways for flood control, irrigation and navigation. For China's imperial rulers, the ability to harness rivers not only saved lives and brought prosperity, but also gave legitimacy to their reign, as natural disasters were taken as a sign that the emperor had lost the mandate of heaven, by which he ruled. This ambition to control water resources has only grown in modern times, with the prowess of technology.

Every Chinese leader since Sun Yat-sen, the founding father of modern China, dreamed of building a massive dam on the Yangtze, which has repeatedly wreaked havoc on its banks during flood season. In the International Development of China, an industrial blueprint he laid out for the Republic of China in 1919, Sun Yat-sen envisioned damming the Three Gorges to improve navigation and provide hydropower for the whole country.

He stated that a dam capable of generating 30 million horsepower (22 GW) was possible downstream of the Three Gorges. However, the revolutionary leader did not live to see this dream realised. It wasn't until 1932 that preliminary work was begun.

The Nationalist Government, led by Sun's successor Chiang Kai-shek began the preliminary work but the Japanese military forces soon took over China. In 1939, during the Second Sino-Japanese War, Japanese military forces occupied Yichang and surveyed the area. A design, the Otani plan, was completed for the dam in anticipation of a Japanese victory over China.

1944 rolled around and China won the war through a peace treaty to reclaim the captured territories. Fol
lowing this, United States Bureau of Reclamation's head design engineer, John L. Savage, best known for his work on the Hoover Dam, surveyed the valleys and drew up a proposal called

the ‘Yangtze River Project.’ About 54 Chinese engineers travelled to the United States for training. Some exploration, survey, economic study, and design work was done, but the government, in the midst of the Chinese Civil War, halted the work once again in 1947.

After the 1949 Communist Revolution, the Chinese Communist Party took power and Chairman Mao Zedong endorsed the project. After the 1954 Yangtze River Floods, in 1956, Mao Zedong wrote "Swimming", a poem about his fascination with a dam on the Yangtze River. He wrote about "walls of stone" and "a smooth lake rising in the narrow gorges" in the poem. But, economic problems including the Great Leap Forward and the Cultural Revolution slowed progress of the project.

During the 1980s, the idea of a dam reemerged when Mao Zedong’s successor Deng Xiaoping brought up the idea again. The idea was strongly opposed by some leading hydrologists, intellectuals and environmentalists, who pointed to its human and environmental costs, from the mass relocation of residents to threats of geological hazards, environmental damage and loss of archaeological sites.

Key problems included the danger of dam collapse, the displacement of some 1.3 million people (critics insisted the figure was actually 1.9 million) living in more than 1,500 cities, towns, and villages along the river, and the destruction of magnificent scenery and countless rare architectural and archaeological sites. There were also fears that human and industrial waste from cities would pollute the reservoir and even that the huge amount of water impounded in the reservoir could trigger earthquakes and landslides.

Some Chinese and foreign engineers argued that a number of smaller and far cheaper and less-problematic dams on the Yangtze tributaries could generate as much power as the Three Gorges Dam and control flooding equally well. Construction of those dams, they maintained, would enable the government to meet its main priorities without the risks.

All these concerns were heavily debated throughout the next decade, which was the most politically relaxed and liberal era in the history of Chinese Communist rule. But following the Tiananmen Square massacre in 1989, open dissent was stifled and the political atmosphere turned oppressive. Four months after the massacre, authorities banned “Yangtze! Yangtze!”, a

book highly critical of the project, and jailed its author, Dai Qing who was a journalist and one of China's earliest environmentalists.

After struggling to make a decision for nearly 40 years and now confident that it could push through the plan, the government put the dam to a vote before the country's legislature, the National People's Congress (NPC), in 1992. Premier Li Peng, who had himself trained as an engineer, was finally able to persuade the National People's Congress.

The plan to build the dam was ratified with 1,767 people out of 2,633 delegates in favour of the project, 177 voting against, 664 abstaining, and 25 members not voting. Thus, giving the legislation an astonishingly low approval rate of 67.75% for China's usually compliant rubber-stamp parliament.

Some delegates said they were blindsided when the Three Gorges Dam suddenly appeared on the NPC's agenda, without advance notice or discussions about the project, according to a 1994 edition of "Yangtze! Yangtze!". Yang Xinren, a delegate from Jilin province in northeastern China, was quoted by the book as saying, "The majority of the delegates are not fully informed of the technical aspects of the project. So no matter how we vote, we vote in blindness."

Construction started on December 14, 1994. President Jiang Zemin did not accompany Li to the official inauguration of the dam in 1994, and the World Bank refused to advance China funds to help with the project, citing major environmental and other concerns. Nevertheless, the Three Gorges project moved ahead.

In 1993, work started on access roads and electricity to the site. Workers blocked and diverted the river in 1997, bringing to a close the first phase of construction. In 2003, the reservoir began to fill, the five-tier ship locks—which allowed vessels of up to 10,000 tonnes to navigate past the dam—were put into preliminary operation, and the first of the dam's generators was connected to the grid, completing the second phase of construction.

Construction of the main wall of the dam was completed in 2006. The dam was expected to be fully operational in 2009, but additional projects, such as the underground power plant with six additional generators, delayed full operation until May 2012.

The dam had raised the water level in the reservoir to 172.5 m above sea level by the end of 2008 and the designed maximum level of 175 m by October 2010. The ship lift, which allowed vessels of up to 3,000 tonnes to bypass the five-tier ship locks and more quickly navigate past the dam, was completed in late 2015 and began officially operating in 2016. This marked the end of the construction phases of the dam.

Location:

The Three Gorges Dam is situated at the upstream of Sandouping, in Yiling District, Yichang, Hubei province of central China, 38km away from the Gezhou Dam at the downstream. The dam's reservoir winds upstream through the narrow valleys of the Three Gorges – a series of steep canyons known for their imposing beauty and once treacherous currents – to Chongqing, a sprawling municipality of 30.5 million people in western China.

After a long but prudent study on 15 alternatives, the dam site for the Three Gorges Project was finally determined at Sandouping, where a number of favourable factors gathered:

- Sandouping has a firm crystalline rock foundation, which is the most important geological condition a massive hydraulic project requires.
- The river valley here is much broader than other sites.
- A small islet, called Zhongbaodao by locals and cleaving the Yangtze River at its centre, offers the most favourable pattern for the river diversion needs scheduled in the first phase of the dam.
- The bedrock of the dam site is sound and intact granite with 100 MPa of compressive strength.
- The faults and fissures in the bedrock are less developed and most of them are well cemented.
- The permeability of the rock mass and the weathered layers in the hills on both sides are also ideal.

- No potentially devastating geological structures were detected within 15 kilometres of its vicinity and the regional seismic activities were also small and not frequent.

Layout and Capacity:

A straight-crested concrete and steel gravity structure, the Three Gorges Dam is 2,335 metres long with a maximum height of 185 metres above sea level. The concrete dam wall is 181 m (594 ft) high above the rock basis.

The plant's construction involved excavation of 102.83 million cubic metres of rock and earth and refill of 31.98 million cubic metres rock and earth. The dam incorporates 28 million cubic metres (37 million cubic yards) of concrete and 463,000 metric tonnes of steel (enough to build 63 Eiffel Towers) into its design.

The 483-metre spillway, located in the middle of the main dam, has 23 bottom outlets dimensioned at 79 metres. Each of its 22 surface sluice gates measures 8 metres wide. The maximum discharge capacity of the dam is 116,000 cubic metres, the biggest in the world.

When the water level is at its maximum of 175 m above sea level, 110 m higher than the river level downstream, the dam reservoir is on average about 660 km in length and 1.12 km in width. It contains 39.3 cubic kilometres of water and has a total surface area of 1,045 square kilometres.

Submerging large areas of the Qutang, Wu, and Xiling gorges for some 600 km (375 miles) upstream, the dam has created an immense deepwater reservoir allowing ocean going freighters to navigate 2,250 km (1,400 miles) inland from Shanghai on the East China Sea to the inland city of Chongqing. On completion, the reservoir flooded a total area of 632 square kilometres of land.

Navigation of the dam and reservoir is facilitated by the five-tier ship locks at both ends of the complex, which allow vessels of up to 10,000 tonnes to navigate past the dam, and a ship lift, which allows vessels of up to 3,000 tonnes to bypass the ship locks and travel past the dam more quickly. At the time of its completion in late 2015, the lift, which was 120 metres long, 18 metres wide, and 3.5 metres deep, was the largest ship lift in the world.

The dam has two powerhouses, flanking the spillway, accommodating altogether 32 sets of turbine-generators. As the world's biggest unit ever made, each has a generating capacity of 700MW. The 643.6-meter-long left powerhouse, 60 metres longer than the 584.2-meter-long right one, houses 14 sets of generators compared to the 12 sets that operate off the right bank.

The rest operating underground, the dam has a total electricity generating capacity of 22,500 MW. This includes the dam's 32 main turbines and the two smaller generators (50 MW each) which power the plant itself. The Three Gorges Dam has been the world's largest power station in terms of installed capacity since 2012. The dam generates an average 95±20 TWh of electricity per year, depending on the annual amount of precipitation. After the extensive monsoon rainfalls of 2020, the dam's annual production was 111.88 TWh, breaking the previous world record of ~103 TWh set by the Itaipu Dam in 2016.

Economics and Contractual Partnerships:

The government estimated that the Three Gorges Dam project would cost 180 billion yuan (US$22.5 billion). By the end of 2008, the spending had reached 148.365 billion yuan, among which 64.613 billion yuan was spent on construction, 68.557 billion yuan on relocating affected residents, and 15.195 billion yuan on financing. By the end of the project, 254.2 billion yuan ($37.23 billion) was spent.

It was estimated in 2009 that the construction cost would be recovered when the dam had generated 1,000 terawatt-hours of electricity, yielding 250 billion yuan. Full cost recovery was thus expected to occur ten years after the dam started full operation, but the full cost of the Three Gorges Dam was recovered by December 20, 2013.

Funding sources of the project include the Three Gorges Dam Construction Fund, profits from the Gezhouba Dam, loans from the China Development Bank, loans from domestic and foreign commercial banks, corporate bonds, and revenue from both before and after the dam was fully operational.

The Three Gorges Dam main equipment order was divided between six foreign groups, drawn into two project alliances. Out of 14, 700MW turbine and generator units, eight were assigned to Alstom, ABB and Kvaerner, and six to Voith, General Electric (GE) and Siemens (abbreviated as VGS). The total worth of the contracts were estimated to be around $850 million

Since the first turbine and generator contracts were signed in 1997, Alstom acquired ABB's power division, and GE Hydro acquired Kvaerner. In March 2004, Alstom was awarded a €163 million contract to supply the four 700MW turbines and associated generators to the project's right bank powerhouse.

Two Chinese equipment suppliers played a major role in the later stages of the first phase. Harbin Power Equipment and Dongfang Electrical Machinery worked with the two foreign groupings, benefitting from extensive technology transfer requirements.

Harbin cooperated with the Alstom, ABB and Kvaerner grouping, and Dongfang with the Voith General Electric and Siemens consortium along with Chinese company Oriental Motor. The last two units of the first phase were almost entirely constructed in China.

Construction tasks, including building of the dikes and the powerhouse, were assigned to Chinese groups. Shortly before the equipment announcements, contracts, worth $800 million, went to Gezhouba Share Holding, Yichang Qingyun Hydropower Joint Management and Yichang Three Gorges Project Construction 378 Joint Management.

Impacts:

"The Three Gorges Dam was built to provide hydroelectric power, flood control, and greater navigation access to the Yangtze River in central China, but what are the drawbacks of constructing such an enormous dam and do the benefits outweigh the numerous negative effects?" is a question that is asked very frequently.

In 2011, the Chinese government admitted the Three Gorges Dam had created a range of major problems. "While the Three Gorges project provides huge comprehensive benefits, there

are urgent problems that need to be addressed, such as stabilising and improving living conditions for relocated people, protecting the environment, and preventing geological disasters," China's cabinet, the State Council, said in a statement.

Some major impacts of the Three Gorges Dam include:

1. Ecological Impacts
2. Relocation
3. Cultural and Archaeological Impacts
4. Agricultural and Industrial Impacts
5. Safety Concerns

Ecological Impacts:

The Three Gorges Dam project has had a severe impact on both the biodiversity and the environment in the Yangtze River valley and beyond. Blocking a river involves a series of physical, chemical and geological consequences that affect the air, soil and water. Many levels of biodiversity have been affected, including both ecosystems and individual species, by the Three Gorges Dam.

It was suggested by the World Commission on Dams and the YWRP in 2000 that the reduction in greenhouse gas emissions from coal fired power plants would counteract these negative effects, but considering the use of fossil fuels during the dam's construction, the decay of organic materials within the reservoir, and the still-high CO_2 emissions, the argument weakens.

The long-term ecological effects of the Three Gorges Dam are now described as 'possibly catastrophic'. Some of those ecological impacts include:

1. Loss of Forest cover:

   In 1997, the Three Gorges area had 10% forestation, down from 20% in the 1950s. After the 1998 Yangtze River floods convinced the government that it should restore tree cover, especially in the Yangtze's basin upstream of the Three Gorges Dam, China accelerated a large reforestation drive. However, after the construction of the dam, even today, the significantly lower forest cover in the area is a major concern.

2. Loss of Biodiversity:
   Concerns about the potential wildlife impact of the dam predate the National People's Congress's approval in 1992. This region has long been known for its rich biodiversity. Large areas of land which have now been submerged were once home to an unprecedented variety of vegetation and animals.

   This biological hot spot developed because the region played a role as a refuge of life during the late Tertiary and Quaternary periods and today we can find a collection of many ancient endemic species. According to a YWRP report in 1999, this biological hotspot is home to 6,388 species of plants, which belong to 238 families and 1,508 genera, almost 20 percent of China's total, including many which are endemic to the region.

   Of these plant species, 57 percent are endangered. These rare species are also used as ingredients in traditional Chinese medicines. The reservoir inundation and the resettlement of close to 1.2 million people have affected at least 36 vegetation types, totalizing up to 550 plant species.

   Already, the percentage of forested area in the region surrounding the Three Gorges Dam has dropped from twenty percent in 1950 to less than ten percent as of 2002, negatively affecting all plant species in this locality.

   Plant species might be the largest group threatened by this dam but there are other groups in danger as well. One of these groups is the collection of terrestrial animals which call the reservoir area home. These animals will be forced upwards as the reservoir begins to fill, a move that has proven to be difficult for many species that are highly adapted to specific habitats

   This difficulty is better understood when the area's ecosystems are considered. According to a work by Z. Shen in 2000, below 800m the area surrounding the reservoir is comprised of evergreen broadleaf forest; between 800 and 1700m the composition has changed to evergreen and deciduous broadleaf mixed forests, and finally, above 1700m the ecosystem is deciduous and coniferous forest.

The presence of this ecosystem change makes adaptation difficult for species being forced upwards by the reservoir. Apart from this, the region also provides habitats to hundreds of freshwater species. The Yangtze River basin is home to 361 different fish species, of which 25 already have endangered status, accounting for 27 percent of all endangered freshwater fish species in China.

Freshwater fish are especially affected by dams due to changes in the water temperature and flow regime. Many other fish are injured in the turbine blades of the hydroelectric plants as well.

Originally the Yangtze basin included a huge floodplain, a common feature of a large interconnected river network and many large lakes which were connected to the main channel. As the population and urban development of the floodplain increased, flood control systems were constructed to protect the urban and agricultural areas.

These flood control systems severed the connections between the many channels and lakes on the floodplain restricting the mobility of many migrating fish species. This situation has worsened with the construction of the Gezhou and the Three Gorges dams which completely blocked the migration routes of several large fish.

This has been detrimental to the endemic ancient fish species: Chinese Sturgeon, River Sturgeon, and Chinese Paddle-fish. The Chinese Paddle-fish is believed to be extinct in part due to the dam blocking its migration.

Yet another group negatively impacted by the dam is riverine mammals including manatees, dugong, and the Chinese river dolphin, which are even more susceptible than fish to the effects of the dam. In the case of these aquatic mammals, sedimentation, altered food web and physical injuries and noise disturbance from increased navigation are all likely to lead to a population decline in these species.

The dam is believed to have contributed to the functional extinction of the baiji, the Yangtze river dolphin or Chinese river dolphin. In fact, Chinese Government scholars even claim that the Three Gorges Dam directly caused the extinction of the baiji.

Though it was close to this level even at the start of construction, the dam further decreased its habitat and increased ship travel, which are among the factors causing what will be its ultimate demise. In addition, populations of the Yangtze sturgeon are guaranteed to be "negatively affected" by the dam.

Apart from all these, Siberian cranes are also speculated to be affected. Of the 3,000 to 4,000 remaining critically endangered Siberian cranes, a large number currently spend the winter in wetlands that have been destroyed by the Three Gorges Dam.

3. Erosion and Sedimentation:
   One major concern and hazard uniquely identified in the Three Gorges Dam is the blocking of sediments. The sedimentation projections till now are not agreed upon. At current levels, 80% of the land in the area is experiencing erosion, depositing about 40 million tonnes of sediment into the Yangtze annually.

   By cutting the flow of the Yangtze River, the dam has retained huge amounts of silt, which not only dampens its flood control capacity by filling the reservoir, but also causes significant erosion downstream. This is because the flow is slower above the dam and much of this sediment will settle there instead of flowing downstream.

   The absence of silt downstream has three effects:
   a. Some hydrologists expect downstream riverbanks to become more vulnerable to flooding.
   b. Shanghai, more than 1,600 km (990 mi) away, rests on a massive sedimentary plain. The arriving silt – so long as it does arrive – strengthens the bed on which Shanghai is built. The less the tonnage of arriving sediment, the more vulnerable is this biggest of Chinese cities to inundation...
   c. Benthic sediment buildup causes biological damage and reduces aquatic biodiversity.

4. Seismic Effects:

   The dam has also had a serious geological impact. Chinese officials and experts admitted at a forum in 2007 that the Three Gorges Dam had caused an array of ecological ills, including more frequent landslides, reported at the time.

   "The huge weight of the water behind the Three Gorges Dam had started to erode the Yangtze's banks in many places, which, together with frequent fluctuations in water levels, had triggered a series of landslides," the Chinese news agency - Xinhua - said, citing officials and experts at a meeting.

   The water in the reservoir saturates and erodes the base of the cliffs, and the fluctuation in water levels changes the weight of the reservoir and the pressure on the slopes, destabilizing the shoreline, geologists say.

   The first disaster came in 2003, shortly after the reservoir started to fill for the first time. As the water reached 135 metres, landslides began to occur. A few weeks later, on a tributary of the Three Gorges, a large chunk of a mountain split off and slipped into the river, killing 24 people, destroying 346 houses and capsizing over 20 boats.

   Other major landslides include two incidents in May 2009 when somewhere between 20,000 and 50,000 cubic metres of material plunged into the flooded Wuxia Gorge of the Wu River and the 97 significant landslides that took place in the first four months of 2010.

   The dam, which sits near two major seismic fault lines, has also been blamed for a surge in earthquakes in the region. Scientists argue that the weight of the large reservoir and the permeation of water into the rocks underneath can trigger earthquakes in regions already under considerable tectonic stress.

   According to a study from the China Earthquake Administration, in the six years after the reservoir was filled in June 2003, 3,429 earthquakes were recorded along the reservoir while only 94 earthquakes were recorded from January 2000 to May 2003.

5. Pollution:
   Another area of change is the pollution in the dam's reservoir area. A major cause for the pollution concern is the fact that water velocity will be slowed in the reservoir allowing pollutants to collect behind the dam where previously they were diluted and washed down the river into the ocean.

   Areas to be inundated will also cause pollution as pollutants begin to leach into the reservoir from below. Alan Sutton's article states that the source of these pollutants within the inundated area include "about 1300 factories and mines, about 4,000 hospitals, around 40,000 graveyards, and about 200 garbage dumping sites".

   Although the dam catalyzed improved upstream wastewater treatment around Chongqing and its suburban areas, over one billion tonnes of wastewater are released annually into the river, which are more likely to leave the water looking stagnant, polluted and murky.

6. Terrestrial Impact:
   In 2005, NASA scientists calculated that the shift of water mass stored by the dams would increase the total length of the Earth's day by 0.06 microseconds and make the Earth slightly more round in the middle and flat on the poles.

7. Floods:
   Flooding is a major problem for the seasonal river of the Yangtze. Millions of people live along the Yangtze river, with many large, important cities like Wuhan, Nanjing, and Shanghai located adjacent to the river and plenty of farm land and China's most important industrial area built beside the river. To prevent and control floods in these areas was a major concern to the Chinese government and the Three Gorges Dam was the solution they came up with.

   According to the Chinese government's 1992 proposal, the top reason for building the dam wasn't power generation, but to prevent flooding. The government promised that

the dam would be able to protect communities around its immediate downstream against a "once-in-a-century flood" but its efficacy has frequently been questioned.

Those doubts recently resurfaced, as the Yangtze basin saw its heaviest average rainfall in nearly 60 years in June 2020, causing the river and its many tributaries to overflow. More than 158 people have died or gone missing, 3.67 million residents have been displaced and 54.8 million people have been affected, causing a devastating 144 billion yuan ($20.5 billion) in economic losses.

Although the dam was effective in alleviating some serious impacts on the middle and lower river, the dam wasn’t efficient enough to prevent the flood. David Shankman, an emeritus professor of geography at the University of Alabama, who has studied flooding on the middle Yangtze, said that the record-breaking water levels showed that the Three Gorges Dam could not prevent severe floods.

Studies by Chinese and foreign researchers over the years, Shankman added, have found that the dam's reservoir is too small to significantly reduce downstream discharge during severe floods, although it does help alleviate flooding during normal years.

Fan Xiao, a Chinese geologist, said “It's like using a small cup to deal with a big tub of water”. According to him, the lowering of water levels in the dam before the summer rains arrive in June, creates only 22 billion cubic metres of storage space which is nothing compared with the sheer volume of floodwater that can flow into the dam during bad years.

During a "once-in-a-century flood" more than 244 billion cubic metres of water can pass through the Three Gorges in two months, while storage capacity of the dam's reservoir can handle only about 9% of that amount. Xiao added that the dam can also only hold back the water for so long, as it has to make room for new rains and in flood season torrential downpours can come in quick succession.

Thus, it is now clear that while the Three Gorges Dam can reduce the intensity of floods coming from upstream to a certain extent, it won't be able to prevent floods

caused by intense rainfall on the middle and lower reaches of the Yangtze or the tributaries in its basin entirely. Further, it has also increased the possibility of floods due to several reasons like increased erosion and sedimentation and reduced forest cover.

Relocation:

One of the most controversial aspects of the Three Gorges project was its enormous cost for villagers who had lived for centuries on the banks of the river. To make way for the dam's massive reservoir, about 1.4 million people were uprooted, their ancestral homes demolished, communities broken up and farmlands flooded.

Building the Three Gorges Dam displaced more people than the three largest Chinese dams before it combined. The reservoir either flooded or partially flooded 13 cities, 140 towns and 1,680 villages along the river banks. Some 1,300 sites of historical and archaeological importance that once lined the middle reaches of the Yangtze River vanished as floodwaters rose.

Displaced residents have complained about inadequate compensation and a lack of farmland and jobs after relocation. Many have accused local governments of embezzling resettlement funds and using excessive force to quell protests. In 2013, the Chinese government acknowledged that some of the funds were embezzled or misused.

Many also faced a reduction in living wages. According to Chen Guojie, a scholar at the government-backed Chinese Academy of Sciences, incomes of migrant families dropped by 20% after relocating, as they were forced to abandon their fertile riverside flatlands to farm on the steep, unsteady slopes.

Cultural and Archaeological Impacts:

As the water level rose in the reservoir, it not only covered thousands of square miles of habitat but thousands of years of history as well. The Three Gorges area has had a rich archaeological and cultural heritage with a record of inhabitants stretching back to Neolithic times.

During the approval process for the dam, a panel of 412 experts were consulted on the various issues surrounding the construction and impacts but missing from that panel were sociologists,

cultural anthropologists, and archaeologists. This lack of concern for the heritage of the Yangtze River valley resulted in a number of programs which rushed to save as many artefacts as possible.

The preservation of this vast record of Chinese history depended on fast, planned rescue but it was impossible to collect and document all the cultural and archaeological sites threatened by the reservoir before its filling. The aboveground "cultural sites" included four categories: ancient buildings, stone sculptures, bridges, and cliff paths.

In order to protect them, three types of preservation measures were implemented: preserving the aboveground cultural sites at their present locations, relocation to higher or safe ground, or intense data collection before a site is submerged. In addition to the above ground sites, more than 829 underground archaeological sites were also examined by the National History Museum of Beijing.

Although these excavation and preservation programs were able to record or protect many significant sites and bring a wave of new information on Chinese history to light, flooding inevitably covered several undiscovered relics. Any information which was not collected before the filling of the reservoir was lost forever.

The 600-kilometre-long reservoir totally flooded some 1,300 archaeological sites and altered the appearance of the Three Gorges as the water level rose. Some sites that submerged in the reservoir included the ancient cities of Guizhou, Kuizhou and Wushan and the hanging coffins site, high in the Shen Nong Gorge.

Agricultural and Industrial Impacts:

The Three Gorges Dam brought with it both positive and negative impacts for the Agricultural and Industrial Sectors. On one hand, the dam's reservoir submerged enormous tracts of agricultural land and numerous industries and affected the fishery industry downstream.

Meanwhile, on the other hand, the dam increases the flow rate of the river downstream before the summer rains, and provides fresh water for agricultural and industrial usage. It provides

easy accessibility to water through irrigation facilities even during the dry season. Since the filling of the reservoir in 2003, the Three Gorges Dam has supplied an extra 11 km3 of fresh water to downstream cities and farms during the dry season. Additionally, the reservoir also improves shipping conditions, promotes electricity generation and powers the Gezhouba Dam downstream, thus contributing significantly to agriculture and industries.

Safety Concerns:

The Three Gorges Dam also caused a lot of safety and security issues to the people of China. The United States Department of Defence reported that in Taiwan, "proponents of strikes against the mainland apparently hope that merely presenting credible threats to China's urban population or high-value targets, such as the Three Gorges Dam, will deter Chinese military coercion."

Destroying the Three Gorges Dam has been a tactic discussed and debated in Taiwan since the early 1990s, when the Dam was still in the planning phase. The Three Gorges Dam is a steel-concrete gravity dam. The water is held back by the innate mass of the individual dam sections. As a result, damage to an individual section should not affect other parts of the dam. So, Zhang Boting, deputy secretary-general of China Society for Hydropower Engineering, suggested that concrete gravity dams are resistant to nuclear strikes.

Meanwhile, Sung Chao-wen, former Taiwanese Ministry of Defence's advisor, called the notion of using cruise missiles to destroy the Three Gorges Dam "ridiculous" and dismissed the idea of such an attack. He cited missiles would only deliver minimal damage to the reinforced concrete, and any attack attempts would need to go through multiple layers of ground and air defences.

Apart from this, there were also concerns on regional safety when around 80 hairline cracks were observed in the dam's structure soon after the first filling of the reservoir. However, an experts group gave the project overall a good-quality rating and the 163,000 concrete units all passed quality testing, with normal deformation within design limits.

In 2019, photographs on Google Earth, in which photographic distortion appeared to show severe deformation of the structure, led to rumours on social media of the dam's potential

collapse. Chinese officials dismissed the claims and reiterated earlier assessments of the safety and structural integrity of the dam. In 2020, as the floods worsened, the rumours re-surfaced and a Chinese hydrologist based in Germany warned of an impending collapse. Along with the warning came fierce rebuttal from state media.

On July 18, 2020, the Chinese state-run press agency Xinhua News Agency stated that "the monitoring records of the Three Gorges Project's operation department showed that the average values of the main parameters such as dam displacement, seepage, and deformation were within the normal range, and the safety indicators of the dam's water retaining structure were stable."

In a July 21, 2020 report, China's Global Times criticized western media reports on their coverage of their Three Gorge Dam report, accusing them of jumping on with bias, taking their reports out of context, and lacking "basic physics knowledge". The report explained that the term, "deformation" was supposed to be a conventional engineering concept, and did not ever claim that their dam had failed structurally.

However, these controversies didn't help to alleviate concerns about the dam's safety and the safety of the people of that region.

Conclusion:

The mega-project of the Three Gorges is the world's largest power producing facility, the world's largest hydroelectric dam and so much. There were many reasons behind the record-breaking dam but it brought with it an enormous cost with respect to ecological and socio-cultural impacts.

As such, the Three Gorges Project has raised several controversies till date and has been responsible for bringing both unprecedented benefits and risks to the people of the Yangtze River Valley and all of China. In some cases, the dam has been the cause of great development and in others, the reason for the devastation of millions of lives and the destruction of the environment and rich cultural heritage of the Yangtze River valley.

However, the Three Gorges Dam has also spurred a greater concern for the protection and conservation of both the environment and the way of life of many Chinese people. Altough many people see the Three Gorges Dam as a 'ticking water bomb', the dam will continue to pose as an example of the future feasibility of hydroelectric power for both the Chinese and the world (if planned in a better, sustainable way).

Anna Hazare and Ralegan Siddhi: A Committed Community

Introduction:

Anna Hazare is an Indian social activist who is well-known for leading movements to promote rural development, increase government transparency, and investigate and punish corruption in public life. In addition to organising and encouraging grassroot movements, Hazare frequently conducts hunger strikes to further his causes—a tactic reminiscent, to many, of the work of Mahatma Gandhi.

Although Anna Hazare received nationwide recognition in the 2000s, after his anti-corruption movements, RTI movement and Lokpal Bill agitation, the stalwart social reformer's journey as a campaigner and catalyst for social change started seven decades ago, when he was making life better for the common man back in 1975 at Ralegan Siddhi.

Ralegan Siddhi and Anna Hazare are not a new addition to the social history of the Maharashtra state. A proud resident of Ralegan Siddhi, Hazare single handedly transformed a once poor village into amongst the richest in India.

In 1975, Ralegan Siddhi was a village in Parner, Ahmednagar, mid-Maharashtra, that was drought-prone and poverty afflicted. With an area of 982.31 hectares and a total population of about 2,500 people, Ralegan Siddhi represented the hapless fate of rural India, when all of India was under political turmoil. Just as it seemed that there was no hope for Ralegan Siddhi, a bright light emerged in the form of Anna Hazare.

Ralegan Siddhi, is today unlike any other village in entire India. The unprecedented economic development it has achieved despite being faced with severe odds and challenges has made this small village so exceptional. From being one of the poorest villages in entire India 3 decades back, today it stands amongst richest villages in entire India.

This complete and unbelievable turnaround against all odds today makes Ralegan Siddhi the pride and a precious jewel in the crown of Ahmednagar district. Besides, more importantly it

stands as an inspiring role model for sustainable economic development for thousands of poor villages across India.

This seemingly impossible transformation without any government support whatsoever was because of the vision and perseverance of the one man - Anna Hazare. This case study showcases the story of not only Anna Hazare, the visionary, but also the story of Ralegan Siddhi, a small Maharashtrian village.

The Story of Anna Hazare and Ralegan Siddhi:

Kisan Baburao Hazare was born on 15 June 1937 in Bhingar, near Ahmednagar. He was the eldest son of Baburao Hazare and Laxmi Bai. He has two sisters and four brothers. He later adopted the name Anna, which in Marathi means "elder person" or "father". His father worked as an unskilled labourer in Ayurveda Ashram Pharmacy and struggled to support the family financially.

In time, the family moved to their ancestral village of Ralegan Siddhi, a village in Parner taluka of Ahmednagar district, Maharashtra, India, where they owned a small amount of agricultural land. A relative took on the burden of providing Kisan with education, taking him to Mumbai because the village had no primary school. The relative became unable financially to continue the support and Hazare's schooling ended in the seventh grade while his siblings never attended school.

Hazare started selling flowers at the Dadar railway station in Mumbai and eventually managed to own two flower shops in the city. He also became involved in vigilantism, joining groups who acted to prevent landlords' thugs from intimidating the poor out of their shelter. Later, Hazare was drafted into the Indian Army in April 1960, where he initially worked as an army truck driver and was later attested as a soldier. He undertook army training at Aurangabad.

During the Indo-Pakistani War of 1965, Hazare was posted at the border in the Khem Karan sector. He was the sole survivor of an enemy attack—variously claimed to have been a bomb, an aerial assault and an exchange of fire at the border—while he was driving a truck.

Apart from surviving the attack at Khem Karan, he also had another escape in Nagaland, where one night, underground Naga rebels attacked his post and killed all the inmates. He had a miraculous escape as he had gone out to return nature's call and hence turned out to be the lone survivor.

The experiences of wartime, coupled with the poverty from which he had come, affected him. He considered suicide at one point but instead turned to pondering the meaning of life and death. At a book stand in New Delhi railway station, he came across Swami Vivekananda's booklet "Call to the youth for nation building". Reading that booklet and the other works of Swami Vivekananda, Gandhi, and Vinoba Bhave inspired him to think deeper.

Hazare said of the truck attack, "[It] sent me thinking. I felt that God wanted me to stay alive for some reason. I was reborn in the battlefield of Khem Karan. And I decided to dedicate my new life to serving people."

After he was honourably discharged in 1975 after completing 15 years of service in the army, he returned to his village, Ralegan Siddhi, and decided to dedicate the rest of his life to serving people and social welfare. However, he did not know how to begin.

While in the army, he used to visit his village for two months, every year during his leave period. The condition of the village was pathetic and awful with all sorts of social evils, moral downfall and badly shattered economic conditions. The village was extremely degraded and unsustainable. The land was barren and undulated. The village was characterised by poor farming practises and water shortage.

The water table was below 20 m, most of the wells used to dry up during summer and the drinking water had to be fetched from the neighbouring villages. As the village is located in the rain-shadow area, the annual rainfall is a meagre 400–500 mm. Most of the rainwater used to run off due to high degree of slope and lack of vegetative cover had washed away the top fertile layer of the soils.

There were no means to harvest this precious resource. Whatever rainwater was collected was sufficient to cultivate only one crop on 300–350 acres of land out of a total 2200 acres of land

available in the village. Not even 30% of the food grain requirements could be met from rain-fed mono-cropping practised in the village. Low productivity of the crop lands forced 80% of the families to survive on only one square meal a day.

As food production was insufficient and no employment opportunities were available in the village, the poor farmers and agricultural labourers forced by their poor economic conditions had only two options - either to migrate to nearby cities of Pune and Bombay to find some manual mobs or join the army of labourers working under Employment Guarantee Scheme of the Government by commuting a distance of about 22 km daily.

Any shortfall in the earnings had to be met by borrowing from the money lenders (Sahukars), the Shylocks of that time. The inability to repay the loans often led to further indebtedness and bondage. A villager, depressed by his impoverished condition went to the neighbouring village and mastered the technique of distilling liquor by using 'Shindi' grass which grew in abundance in the area.

His success attracted many more in the trade and the number of breweries gradually rose to 40. They were aware that what they were doing was socially and morally incorrect, but the circumstances forced them to adopt this profession for their livelihood. The helplessness due to poverty and indebtedness led people to desperation and ultimately to alcoholism.

Even school children fell in the den of drinking. The wide spread alcoholism brought many undesirable and anti-social elements and the village emerged prominently on the crime records of the police department who along with money lenders exploited every bit of opportunity for their selfish ends.

The shortage of water also led to disease from unsanitary conditions and water reuse for multiple purposes. There were large scale migrations, ill health and alcohol-driven violence. The combination of poverty, unemployment, alcoholism, indebtedness, mutual suspicion, use of money and muscle power for malpractices, not only shattered the village economy but also degraded the social/community life.

Majority of children were denied access to education - hardly 10% of children attended schools, dropout rates were high. It was difficult for girls to step out in village streets which were full of rogues and drunkards. Social strife and tension became routine, conflicts and crimes became daily chores. The community was divided along the lines of caste, creed, political following and economic status.

Thefts, arrests, extravagance on festivals and marriages, funeral rites, discrimination against lower castes and atrocities on women were common. Women had to bear the brunt of drunk males in various forms. Children were denied their basic rights to minimum needs, women were humiliated and all the old value systems and cultural norms of a civilised society had receded to the rock level.

The devastating drought of 1972 made the situation from bad to worse. The Government in its bid to help fight the drought, constructed a percolation tank but due to faulty design, lack of supervision, and high rate of percolation, it failed to serve the purpose. Another help came from Tata Relief Committee and Catholic Relief Society in the form of construction of check dams, deepening of wells and provisions for medical relief.

Despite all these, much could not be achieved in any of these initiatives due to lack of people's participation. The conditions in the village were rather hostile to any reconstructive initiative for an outside agent. It was at this rather crucial time that Anna Hazare appeared on the scene.

Hazare's house was in a hamlet just half a kilometre away from the centre of the village. Hazare avoided going to the heart of the village due to this pathetic condition. He always felt helpless since he could not do anything to change the conditions prevailing in the village. When he discovered his life purpose and decided to dedicate his life for social causes in 1975, he believed change should begin from home.

Swami Vivekananda's words resonated in his mind - people would not listen to philosophical ideologies with empty stomachs. Social change is not possible if people are haunted by the daily problem of making two ends meet.

He started helping the people of Ralegan Siddhi to earn their livelihood by employing them for seasonal jobs. But he soon realised that farming is what would truly heal the wound of poverty and bring back happiness among the villagers. For that, the enormous water crisis needed to be resolved. Hazare taxed his brains on how to solve this crucial problem.

He remembered that Late Mr. Vilasrao Salunkhe had in 1972, started experiments in watershed development and water management in some villages near Saswad in Pune district. His work used to be frequently discussed in informal gatherings everywhere. So, Hazare visited his project and was inspired. The visit gave a direction to his ideas and he decided to undertake similar work of watershed development in his village.

Hazare organised Gram Sabha meetings to explain to the village residents the work of Mr. Salunkhe and its adoption in Ralegan Siddhi. All the villagers were impressed by this idea and decided to start a similar programme in Ralegan Siddhi. Initially they decided to repair the existing percolation tank which was heavily leaking.

Hazare considered all factors, recognized the importance of people participation and encouraged the villagers to donate their labour. He turned towards community involvement for all government or self supported developmental projects. He believed that voluntary labour was necessary to ensure minimum dependence on the government. In addition, he formed a youth group called Tarun Mandal.

The cause of water seepage in the percolation tank was ascertained and work of providing core wall by digging puddle trench upto the level of hard rock was undertaken on upper side of the bund through voluntary labour of villagers. Satisfactory completion of the work resulted in retention of water in the tank resulting in recharging of ground water aquifers.

This enthused the villagers and they decided to implement the concept of watershed development, i.e. ridge to valley approach for soil and water conservation.. Implementation of watershed programme involved a lot of expenditure and Hazare approached the then Director of Agriculture, Mr. Dikshit, and requested his help.

He expressed his desire to undertake water conservation work in his village under his guidance and assured the Director that he and his colleagues from village will actively participate in implementation of watershed development programme and will provide labour voluntarily.

After some days, Mr. Dikshit paid a visit to Ralegan Siddhi along with his subordinates and made a geographical survey. He was convinced that the topography of the village was suitable for undertaking the watershed development programme and took a decision to implement it.

On resumption of the watershed development work in the village, Hazare started supervising the work at sites from dawn to dust, without taking a farthing as remuneration. He considered it as social work; and day by day his experience and knowledge was building up. With his experience and knowledge, he constructed many water harvesting structures with people's participation.

The people of Ralegan Siddhi took their turn and maximised their involvement in community projects by investing thousands of hours in developmental activity. Common interest triggered human muscle power into the watershed management of the village. The ridge-to-valley programme involved structures like gully plugging, loose boulder structures, gabion structures, nulla bunding, cement check dams etc.

The cost involved in constructing cement check dams was prohibitive and hence Hazare developed modified gabion structures with a core wall which reduced the cost considerably and was as effective as cement check dams. Similarly, on the ridge lines where CCT was not possible, shallow soak pits were dug in order to collect rain water so that through seepage the water would be available to the surrounding plantation. This resulted in an increase in plant survival and their vigorous growth. This was also a novelty of the Ralegan Siddhi programme.

Over time, 48 earthen nulla bunds, 10 cement bunds and 16 gabion bunds were constructed and a large lake was also dug. The watershed development work helped in conserving each drop of rainwater in the village itself and in recharging the groundwater aquifers. This ultimately raised the water table.

In the same village where earlier it was not possible to cultivate more than 300–350 acres of land for one crop, now the villagers are harvesting two crops in 1500 acres of land. The village could also dig more wells. The number of wells rose from a mere 35 to 135. Realising the importance of water the villagers decided to form cooperative societies well-wise.

Due to availability of water for irrigation, agricultural production boosted up. This resulted in bringing more land under cultivation and developments like double cropping, change of farming system, horticulture plantations, vegetable cultivation, dairy farming etc. could take place. Cultivation of water-intensive crops like sugarcane was banned and crops such as pulses, oilseeds, and certain cash crops with low water requirements replaced them.

The villagers under Hazare's guidance, undertook fodder development, continuous contour trenches and loose boulder structures on 500 acres of land. Open grazing was completely banned with a new emphasis on stall-feeding and the cattle owners were asked to cut fodder only from abandoned land. They also planted three lakh saplings and ensured that they survived. All efforts were made to retain rainwater and protect soil from erosion, starting from the top of the hills, hill slopes, and the ground level.

Earlier only 300 litres of milk was sold from the village. Now the milk production has gone up to 4000 litres. This milk is purchased by cooperative and private dairies. This brings in Rs. 1.3 to 1.5 crores (13 to 15 million) annually to the village. The dairy business has flourished as a subsidiary to agriculture which has provided a new income generation avenue to the unemployed youths of the village. The village even has a milk bank now.

The agricultural development created a lot of employment in the village itself. Not only has the distress migration completely stopped, but now wage labourers have to be hired from other villages in order to get various intercultural operations done in time. All this resulted in substantial increase in per capita income of the villagers.

The per capita income of the villagers has increased from Rs. 225 to Rs. 3500. This has completely transformed the economy of the village. The living conditions of the villagers have improved and the gap between the haves and have-nots has narrowed down. The death by malnutrition and starvation has literally vanished from the village.

Apart from watershed development, Hazare convinced villagers to adhere to: Alcohol prohibition, Family planning, A ban on open grazing, A ban on felling trees, A ban on dowry and Voluntary labour.

Liquor distilling units were removed and prohibition was imposed. Today, the villagers have also completely given up brewing liquor. Nobody sells liquor in the village. It was also decided to ban the sale of tobacco, cigarettes, and beedies in the village. To implement this resolution, the youth group performed a unique "Holi" ceremony twenty two years ago.

The festival of Holi is celebrated as a symbolic burning of evil. In a similar way, the youth group brought all the tobacco, cigarettes, and beedies from the shops in the village and burnt them in a Holi fire. Since then, the shopkeepers have not sold cigarettes, beedies and tobacco either.

After the economic transformation of the village, villagers constructed buildings worth Rs.1 crore for school, hostel and gymkhana and renovated the old village temple through their cooperative efforts, financial contributions and shramdan.

Hazare, along with the youth of Ralegan Siddhi, worked to increase literacy rates and education levels irrespective of gender. Through community volunteer efforts, they started a pre-school in 1976 and a high school in 1979. The villagers formed a charitable trust, the Sant Yadavbaba Shikshan Prasarak Mandal, which was registered in 1979.

In 1980, Hazare started the Grain Bank at the temple, with the objective of providing food security to needy farmers during times of drought or crop failure. Rich farmers, or those with surplus grain production, could donate a quintal to the bank. In times of need, farmers could borrow the grain, but they had to return the amount of grain they borrowed, plus an additional quintal as an interest. This ensured that nobody in the village ever went hungry or had to borrow money to buy grains. This also prevented distress sales of grain at lower prices at harvest time.

Like any other village in India, there was a social problem of untouchability in Ralegan Siddhi too. The Tarun Mandal worked to ban the dowry system, caste discrimination and untouchability. The social barriers and discrimination that existed due to the caste system in India have been largely eliminated by the Ralegan Siddhi residents.

Mass marriages are arranged in the village (generally 25 to 30 marriages at a time) in order to curb expenditure. Marriages of Dalits are held as part of these community marriage programs together with those of other castes. This has further helped in removing caste barriers and promoting social cohesiveness.

The Dalits have become integrated into the social and economic life of the village. The upper caste villagers built houses for the lower caste Dalits by shramdaan and helped to repay their loans. It was Hazare's moral leadership that motivated and inspired the villagers to shun untouchability and caste discrimination.

Today, people of all castes and creeds live together in peace like members of the same family at Ralegan Siddhi. Not only do all castes celebrate festivals and traditional events together, but invitations to public events are issued in the name of “the Ralegan Siddhi family” rather than individual names.

In the last 35 years, many institutions and cooperatives like the Gram Panchayat, Cooperative Consumer Society, Cooperative Credit Society, Cooperative Dairy, Educational Society, Women’s Organisation and Youth Organisation, with different mandates are operating in Ralegan Siddhi. There are 14 vividh karyakari societies in the village, dealing with forestry, water, co-operative, school, etc. \

Till date, no elections were held for the selection of members of these institutions. The members were elected unanimously by the villagers in the Gram Sabha. The Gram Sabha has emerged as a powerful forum for taking collective decisions at the village level. All the developmental programmes are implemented in Ralegan Siddhi after taking the consent of the Gram Sabha.

Since the last 15 years, thousands of visitors, not only from neighbouring states of India, but also from abroad, have visited & are still visiting Ralegan Siddhi to study the impact of watershed development. They include researchers, academicians, farmers, government officials, people's representatives and students.

While implementing the watershed program trained manpower was required and realising that there was a paucity of trained manpower in Ralegan Siddhi, a training institute to impart training in watershed development was established. So far, about 17–18 thousand people from different states of India have been trained at that Training Centre on Watershed Development.

After the success of the watershed development programme in Ralegan Siddhi, Hazare replicated it in the neighbouring four villages and the same project is being replicated in 80 – 85 other villages of Maharashtra. Today, Ralegan Siddhi is being taken as a role model for other villages by not only the Maharashtra government but also by other state and national governments.

At Ralegan Siddhi, massive tree plantation has been undertaken, and hills have been terraced to check erosion. Large canals with ridges on either side have been dug to retain rainwater. As a result, it has recently become possible to raise three crops a year.

The village's biggest new achievement is undoubtedly in the area of non-conventional energy. All the streets in the village are lit by solar lights, each with a separate panel. There are four large community biogas plants and one of them is fitted to the community toilet. There is a large windmill used for pumping water and a number of households even have their own biogas plants.

Anna Hazare and his community really worked hard to make these critical projects possible and their hard work and endurance paid off quite handsomely. Hazare has also been rightly honoured by the Government of India for his efforts by awarding him the Padma Bhushan, the third-highest civilian award, in 1992.

Anna Hazare has had many more achievements in his life after Ralegan Siddhi but his roots always remain at Ralegan Siddhi. It was Hazare's work that transformed the village to become

self-sufficient. However, the village's journey towards prosperity and beyond is still in progress. The village is now in an attempt to shift to organic farming.

The succinct answer to the question of the village's future lies in Anna Hazare's own words: "The process of Ralegan's evolution to an ideal village will not stop. With changing times, people tend to evolve new ways. In future, Ralegan might present a different model to the country."

Hazare's Approach Towards Ralegan Siddhi:

Sustainable development was the motto of all the reforms undertaken at Ralegan Siddhi. It was understood that any development achieved at the cost of the environment will not be sustainable and nature will strike back in one form or another. Keeping this precept in mind, Anna Hazare encouraged voluntary people participation. He used several people-centred approaches for natural resource management at Ralegan Siddhi. They include:

1. **Persuasion:**
   First of all, Anna went through a careful envisioning of the deteriorating situation in village life and decided to initiate through religion-moral undercurrent by persuading the people for reconstruction of Sant Yadava Baba temple. But he failed to impress and influence the people at large, primarily because the people were too busy with their own business and worldly affairs.

2. **Gandhian approach:**
   The second step was to set up examples by self-practising. Initially it went on unnoticed but in due course it gathered momentum. Particularly, he tried to organize the youths of the village under 'Tarun Mandal'. Besides, participation from all the sections of society was ensured and encouraged. Thus, the construction of the temple was completed by voluntary labour only.

3. **Creation of a common platform**
   Keeping all the differences and disparities aside, a common platform and meeting ground was created in the form of Sant Yadav Baba's temple. People started sitting in

groups during evenings and discussing the affairs of the village and common concerns. Thus, the process of friendship, cooperation and communication started.

4. **Moral cleansing:**
   Mr. Anna Hazare himself took this initiative. During informal chats he started quoting the sayings of great men like Swami Vivekanand, Mahatma Gandhi, Vinoba Bhave, etc. He also used the ideals of Sant Yadav Baba whose memories were still alive in the minds of the people.

   The Bhajans (hymns) and religious discourses, etc. that were played through the public address systems at the temples in the early hours of the day were used to enlighten the people. Thus, a change in the general attitude of the people was brought about by moral cleansing.

   This process facilitated the people of different castes and classes to be at equal footings in mental/moral level and the differences among the people started sinking. Untouchables were allowed to enter the temple and share their thoughts with others.

5. **Selfless leadership:**
   Anna himself invested all the money he had for purchasing building materials for the temple before asking others to contribute. He started living in the temple with a resolve to remain a bachelor and broke all his family ties as a form of penance.

   He has not visited his parents, who live at a stone's throw distance from the Guest House, for the last 17+ years. The villagers were impressed by his sense of sincerity, selflessness and sacrifice and he emerged as their undisputed leader by winning their hearts.

6. **Identification of the most pressing common problem:**
   The main reason for disintegration, division and distress of the village society was the lack of a sound livelihood support system. The economy of the village was agrarian and shortage of water for irrigation was the major constraint to its development. Thus, the

assured availability of water was collectively identified as the top priority in a meeting of villagers.

7. **Initiating the process of change at individual level:**
   The Gandhian dictum is that change should begin at the level of individuals. If the individuals change, the village will change; and if the villages change, the country will change. This can be clearly observed in the approach followed in the case of Ralegan Siddhi.

   Stress on personal morality, abstaining from alcohol and cigarettes are essential components of a voluntary personal code of conduct imposed by the community itself on the village. Besides, it has been linked with a broader vision of social morality encompassing social equality and egalitarian distribution of benefits of growth.

   The concept of personal morality has been chiefly drawn from Hindu religion. An oath for giving up drinking was taken up by the villagers at the temple. Personal and social morality have been interlinked nicely to serve as the foundation of the new social order. Untouchability and discrimination of dalits have

   vanished.

8. **Socialization of costs and surpluses:**
   In the implementation of resource management activities e.g. developing public utilities, tree planting, deepening of wells etc., voluntary labour (Shramdan) is an essential component. This has helped in socialising the costs and has helped develop a sense of belonging among the people, in addition to lowering labour costs of the activities.

   In addition, 25% of the surplus generated from community resources are set aside as village funds which are utilised for other community projects. Special attention is paid to the development of the deprived sections. This safety set has helped greatly in securing the participation of the resource poor farmers.

Assistance to cultivation of harijan's land by better off farmers, provision of grain bank to make food grains available during slack periods at low cost, construction of masonry (pucca) houses for harijans with the support of community etc. have helped in reducing the disparities and strengthening the sense of togetherness.

9. **Democratic decision making process:**

   People in the village are not the blind followers of Anna Hazare. Every new initiative is thoroughly discussed in village meetings. Pros and cons of any new initiative are considered. Plans for implementation of a particular scheme and code of conduct are openly discussed and a select group of people carry out and supervise the works. Thus, at every stage, the involvement of people in decision-making is very important.

10. **Social reform with strict discipline:**

    Once the decision is taken by the villagers to eradicate a particular social evil, it is implemented with strict discipline in letter and spirit. As in case of drinking, any one found drunk in the village used to be tied up with the pillar of the temple and beaten by the military belt of 'Anna'. Since it used to be a collective decision nobody could dare oppose it. Similarly, dowry and extravagance was also curbed.

11. **Need-based planned socio-economic development:**

    Since all the decisions pertaining to launching any scheme are taken in the village assembly, the decisions reflect the needs and aspirations of the community.

    For example, the top priority was accorded to the rain water harvesting and management of the four village watersheds. Every drop of rain was trapped by developing a drainage system, trenches, check dams, drainage plugs, percolation tanks etc. and by developing and designing micro-watershed specific schemes.

    This initiative recharged the ground water and now enough water is available all year round at 6.5 m depth as compared to the ground water depth of 20 m earlier. This was followed by the regeneration of plants, grasses, development of best locally suited farming systems, continuous watch and monitoring of water distributions to irrigate

crops in a judicious manner, selection of crops according to soil moisture and needs of the people.

Similarly, to meet basic minimum needs of the people, solar street lights, community latrines, biogas plants for cooking and above all a well managed high school was installed and is being run. Today, not only the children from the village but also from the cities like Mumbai and Pune come to study in the village school. The preference is given to the so-called “spoiled” and “failed” children in admissions to encourage these children.

12. Cooperative management system:

Most of the villagers are farmers. Hence, it is beyond their repaying power to go for bank loans for irrigation wells individually. To overcome this problem, a cooperative system of irrigation has been adopted. Two or more farmers develop the source collectively, share the water equitably and repay the bank loan in proportion to the land irrigated by that source.

This system has enabled access to irrigation even to the poorest of poor farmers on equal terms. To avoid any confusion or misuse of water, Water Ration Cards are maintained by farmers. Each farmer can use the water as per their allotment. A second turn to any farmer is allowed only when all the farmers have taken their first turn.

13. Special focus on women:

The availability of drinking water, fodder, toilet facilities, bathroom etc. have reduced the drudgery of women. The moral upliftment of the village has improved the status of women at home and in society, due to change in attitudes of men towards women.

Mahila Mandals (Women's Groups) manage women-specific issues. Besides, an all women's panchayat (assembly) is another step to encourage the participation of women. The village milk dairy is run by women. Atrocities on women are taken up very seriously and the culprit is dealt strictly. Even husbands are not spared.

However, the village still needs more time to achieve gender equality. A scheme of sewing, cloth cutting and tailoring has failed particularly due to low demand and lower returns. Lack of a proper marketing strategy is the prime cause of this failure. In general, due to added development activities, the women feel that they have regained their lost dignity and have better representation in the decision making process, today.

14. Facilitating village organisations:

To manage the village affairs, village organisations have been formed. Each of these units are separately registered societies with a fair degree of independence and are competent enough to take operational decisions and ensure the smooth functioning of each and every activity.

Analysis on Ralegan Siddhi's Development:

Achievements of Ralegan Siddhi:

- Successful abolition of social evils like alcoholism, dowry, corruption and the caste system to pave way for development.
- Successful implementation of voluntary codes e.g. ban on grazing, protection of green cover, check on extravagance on marriages etc.
- Social acceptance of the use of public toilets for biogas.
- Successful implementation of development schemes through cooperatives with the support of Government and bank loans.
- Regeneration of watershed resources through people's participation, a living example of watershed development and management.
- Successful involvement of the people in formation of development schemes in a democratic way through village meetings thus showing participatory sustainable development is possible.
- Non-degrading and sustainable utilisation of natural resources as well as generating alternative sources of income to enhance the economy at family and village levels.
- Development of agriculture and allied sectors by better farming practises and cropping patterns, judicious use of water by introducing drip irrigation system, yield enhancement etc. as a result the village where nearly three-fourth population was below poverty line, has become self-sufficient and is surplus in food grains, today.

- The quality of life of women and people belonging to backward classes because of special attention and enough scope for self development.
- Strengthening of infrastructure, life, drinking water, sanitary facilities, biogas, postal, baking, roads, schools, health centres etc. with community participation and by availing Government schemes.
- Development of managerial skills and capability among people with low level of education, exposure and training.
- Evolving social techniques to establish civil control over public spaces and creation of a civil society which is responsible to itself and its environment and responsive to the needs of its members.
- An appreciable change in the attitude of the people with high degree of moral standards and ethics.
- Overall improvement in the quality of life of the people, and conservation and use of the natural resources in a very sustainable manner.

Weaknesses of Ralegan Siddhi:

- Although there has been tremendous improvement in the status of women and much has been done, more remains to be done to involve them fully in the process. This means that women's development needs specialised extra effort.
- There is no effort towards the development of agro-based rural/small scale industries to enhance the value of the products and keep the participation of the people intact.
- The managerial capability is weak and it is reflected in the failure of the cloth cutting and tailoring scheme and thereby weakening the participation of women.

Lessons to be Learnt from Ralegan Siddhi:

- Leadership in voluntary action does not need any formal degree of education. But it demands a high degree of selflessness, egalitarian attitude, foresight and humane virtues to win the trust of the people.
- A mix of commitment with flexibility, sensitivity, innovativeness and autonomy are essential for success.
- Moral cleansing is a key step that reminds people of their moral and social obligations as well as sensibilize them for community/collective action.

- People understand their environment much better than anybody else from outside. People's participation is an essential element and prerequisite for any development initiative to be successful. Hence, it needs to be designed into development programs from the beginning.
- Involvement and participation of the people is possible provided there is a committed and sincere leadership to educate, organise and motivate the people for the attainment of a common goal.
- Rich and poor, high and low, men and women, can cooperate with each other if there is a sound reason and shared concern.
- The basic components of the environment, particularly land, water and vegetation are the vital links to bring rural people together as their livelihoods are closely dependent on these natural resources.
- The efforts at participation must be total. No one in the community must be left out of the fold of the process.
- Holistic approaches to people's participation in sustainable development are necessary for involving people wholeheartedly.
- The approach being employed for participation must have the potential to generate the spirit of cooperation, caring and sharing, adjustment, harmony, self-help, self-reliance and special emphasis on the resource-poor villagers particularly women.
- The initiatives to mobilise people should be people/community and place specific. Any kind of generalisation may be harmful.
- The efforts for participatory development must aim at the improvement in the quality of life of the people and should be designed for people first. They must touch the basic day to day needs and must ease out people's hardships and help in their self-development.
- Need-based planned initiatives and their proper prioritisation by the people themselves through democratic decisions with focus on the poorest and weakest and proper consideration for gender issues ensures better and fuller participation.
- The first benefit must go to the poorest of the poor and first input must come from the richest of the rich to sustain the emotions and confidence of the poor.
- The weak, poor and women need special consideration and concessions for their fuller participation.

- Shramdan (voluntary labour) is a no cost method to promote, facilitate and catalyse people's participation in sustainable village development.
- Strict formal rules and regulation are not necessary for encouraging people's participation in sustainable development. People themselves can develop their moral codes for cooperation. Such voluntary codes with strict discipline approved by the people themselves do miracles.
- Sustained efforts over a considerable long period of time are required for the people to gain confidence for self-development.

Challenges in Mirroring Ralegan Siddhi:

- It is not easy to find a devoted and committed leader like Anna Hazare in the second generation to keep the process going. His effort to choose a leader so far remains unresponded.
- Moral cleansing at the individual level in today's materialistic world where personal liberties and human rights come in the way is a very difficult proposition and may pose problems in other areas.
- Ralegan Siddhi has a more or less homogeneous character having groups of people with not much economic disparity or diversity in caste/religion. The Neo-Buddhists are close to Hindus so there was no problem but in the case of other diverse populations being part of the society, it may be difficult to organise them like in Ralegan Siddhi.
- Anna has been the undisputed leader of the village and nobody objected to the initiatives floated by him. At the most, there used to be only mild queries on the part of the villagers, in case of disagreement. It may not be so easy to generalise the dedicated leader driven approach.
- It is easier to transform a virgin and underdeveloped area like Ralegan but very difficult to develop semi-developed areas.

Conclusion:

Ralegan Siddhi’s development into a sustainable model of a village republic is not restricted to the narrow angle of materialistic development, i.e. structures in watershed or economic development. The developmental process in Ralegan Siddhi is beyond it. There is a social and nationalistic thread passing through the process of their change.

Today, when every country is facing the problem of environmental degradation and international leaders and scientists are worried about the future of the Earth alike, Ralegan Siddhi boasts an inspiring story about sustainability as the solution to recreate and maintain ecological balance.

Ralegan Siddhi proves that the development of an individual, family and village is not possible by exploiting the environment indiscriminately, but by the sustainable use of available resources. It shows how a simple, sustainable project like watershed development can change the fortune of an entire village and transform it from a highly degraded ecosystem in a semi-arid region of extreme poverty to one of the richest in the country.

Ralegan Siddhi, now 25 years old, is a fine example which demonstrates that it is possible to rebuild natural capital in partnership with the local economy. Only if every village in the world could replicate this vision and work collectively as a community to craft such sustainable ecosystems!

Hazardous Wastes: An Overview

Introduction:

What is hazardous waste? In its most basic form, the answer to that question can be quite simple.

Hazardous, or toxic wastes are wastes with a chemical composition or other properties that make it capable of causing illness, death, or some other harm to humans and other life forms when mismanaged or released into the environment. They are any unwanted material in all forms that can cause harm when inhaled, swallowed, or absorbed through the skin. Toxic material can be either human-made or naturally occurring in the environment.

Waste is usually considered as toxic if it is poisonous, radioactive, explosive, carcinogenic, mutagenic, teratogenic, or bioaccumulative in nature. They are usually poisonous byproducts of a wide range of activities, including manufacturing, farming, water treatment systems, construction, automotive garages, laboratories, hospitals, and other industries.

The waste may be liquid, solid, or sludge and contain chemicals, heavy metals, radiation, dangerous pathogens, or other toxins. Even many of today's households generate toxic waste, from items such as batteries, used computer equipments, and leftover paints or pesticides.

Hazardous wastes have become more abundant since the industrial revolution, causing serious global issues. Disposing of such waste is a major public health issue. Numerous products contain toxic chemicals that can harm the environment if not disposed of properly to prevent the pollution of the air and contamination of the soil and water.

They can harm people, animals, and plants, whether it ends up in the ground, in streams, or even in the air. Disposing hazardous wastes properly has become even more critical with the addition of numerous technological advances containing toxic chemical components, such as mercury and lead, which persist in the environment for many years and accumulate over time.

Thus, developing a proper regulatory program to ensure the safe handling of hazardous wastes is extremely important. Developing a regulatory program that ensures the safe handling of such dangerous wastes, however, demands a far more precise definition of the term.

Definition:

As mentioned above, one of the challenges facing proper hazardous waste management and disposal is that definitions of hazardous wastes vary from one country to another. The term hazardous waste is in itself ambiguous. Effective governmental programs must provide appropriate, scientifically defensible, and clear legal definitions for wastes being regulated. However, this can be difficult.

In the U.S., for example, the Environmental Protection Agency(EPA) took nearly four years after the passage of the first U.S. hazardous waste law in 1976 to promulgate regulations that defined hazardous waste. This definition, however, used broad terms, included many exceptions and has needed modification from time to time. Other nations have had similar experiences. Definitions often do not have a solid scientific foundation and may allow exemptions as a result of political influence.

A general definition describes hazardous wastes as wastes or combinations of wastes that pose a substantial present or potential hazard to humans or other living organisms or natural resources because they are non-degradable and persistent in the environment, are deleterious to human health or natural resources, can be biologically magnified, can be toxic, may otherwise cause detrimental cumulative effects.

Hazardous wastes contain organic or inorganic elements that, due to their toxicological, physical, chemical, carcinogenic or persistency properties, may cause:

- Explosion or fire;
- Infection, including infection by parasites or their vectors;
- Chemical instability, reactions or corrosion;
- Acute or chronic toxic effects;
- Cancer, mutations or birth defects; or
- Damage to ecosystems or natural resources.

In addition to these properties, the location or utility of a substance may also determine whether it is a hazardous waste. A pesticide used to treat crops for instance, may be considered hazardous after it has migrated to surface or groundwater. On the other hand, if an industry finds a use for a particular hazardous waste in its manufacturing process, the substance may become a valuable economic input.

Meanwhile, the Resource Conservation and Recovery Act(RCRA) of the U.S. Government defines hazardous waste as:

> A solid waste, or combination of solid wastes, which because of its quantity, concentration, or physical, chemical, or infectious characteristics may (a) cause, or significantly contribute to, an increase in mortality or an increase in serious irreversible, or incapacitating reversible, illness; or (b) pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, or disposed of, or otherwise managed.

This broad statutory definition provides a general indication of which wastes are intended to be regulated as hazardous, but it does not provide the clear distinctions necessary for industrial waste handlers to determine whether their wastes pose a sufficient threat to warrant regulation or not.

There are therefore two definitions of hazardous waste under the RCRA program: a statutory definition and a regulatory definition. The statutory definition cited above is seldom used today. It served primarily as a general guideline for EPA to follow in developing the regulatory definition of hazardous waste. The regulatory definition is an essential element of the current RCRA program. It precisely identifies which wastes are subject to RCRA waste management regulations.

While this hazardous waste definition is objective, it can be extremely complex. This has resulted in the US agency creating a list of questions that waste-generators can ask to determine whether or not they are indeed producing “hazardous” wastes:

1. Is the material in question a solid waste?
2. Is the material excluded from the definition of solid waste or hazardous waste?

3. Is the waste a listed or characteristic hazardous waste?
4. Is the waste delisted?

In order to be a hazardous waste under RCRA regulation, the material must get the answers - yes, no, yes and no - in order.

Sources:

The hazardous wastes often include by-products of industrial, domestic, commercial, and health care activities. Rapid development and improvement of various industrial technologies, products and practices result in hazardous waste generation. Most hazardous wastes are produced in the manufacturing of products for consumption or further industrial application.

All sources that discharge liquid, gaseous or solid wastes that fit the above definitions of hazardous wastes can be regarded as sources of hazardous wastes. Some major sources are agricultural land and agroindustry, households, mines and mineral processing sites, health care facilities, commercial facilities, institutional facilities, industrial sites, solid waste disposal sites, contaminated sites and building materials.

A brief description of these hazardous waste sources and their pollution routes in the environment are listed below:

1. **Agricultural land and agro-industry:** Hazardous wastes from agricultural land and agro-industry can expose people to pesticides, fertilizers and hazardous veterinary product wastes. Farms are a major source of these wastes, and agrochemicals can leach into the environment while in storage or can cause damage after their application.

2. **Domestic sites:** Households stock various hazardous substances such as batteries and dry cells, furniture polishes, wood preservatives, stain removers, paint thinners, rat poisons, herbicides and pesticides, mosquito repellents, paints, disinfectants, and fuels (i.e. kerosene) and other automotive products. These can present a variety of dangers during storage, use and disposal. They are the most overlooked toxic and hazardous wastes and are often improperly disposed of due to the same.

3. **Mines and mineral processing sites:** Mining and mineral processing sites handle hazardous products that are present in the additives, the products and the wastes.

4. **Health care facilities:** Health care facilities are sources of pathological waste, human blood and contaminated needles. Specific sources of these wastes include dentists, morticians, veterinary clinics, home health care, blood banks, hospitals, clinics and medical laboratories.

5. **Commercial waste sources:** Commercial waste sources include places like gasoline stations, dry cleaners and automobile repair shops (workshops) among others. The types of hazardous wastes generated by these sources depend on the services provided.

6. **Institutional waste sources:** Institutional hazardous waste sources are mainly research laboratories, research centers and military installations. Some military installations are used for the manufacture and storage of ammunition, and they are also used as testing grounds for military hardware. Military establishments also carry out activities that generate other types of hazardous wastes of household, commercial and industrial nature.

7. **Industrial waste sources:** Hazardous wastes are created by many industrial activities. For example, the hazardous wastes from the petroleum fuel industry include the refinery products (fuels and tar), impurities like phenol and cyanides in the waste stream, and sludge flushed from the storage tanks.

8. **Solid waste disposal sites:** These are mainly disposal sites for municipal solid waste, but hazardous wastes that have not been properly separated from other wastes are also at these sites. In developing countries, solid waste disposal sites are a major source of pollutant-laden leachate to surrounding areas, as well as recyclable materials for scavengers, who can collect and resell waste materials that have been exposed to or that contain hazardous substances.

9. **Contaminated sites:** These are sites that are contaminated with hazardous wastes due to activities that use or produce hazardous substances or due to accidental spills. Former

sites of industries that used or produced hazardous materials are one type of site which belong to this group.

10. **Building materials:** Roofs, pipes and other building materials made of substances incorporating asbestos, copper, or other materials may present a source of hazardous waste.

Classification:

Waste characterization and classification is a critical step in determining how a waste should be handled in bulk or in packaged form.

Toxic waste products are generally divided into three categories:

1. **Chemical wastes:** They are those that are considered corrosive, flammable, reactive (that is, chemicals that interact with others to create explosive or toxic by-products), acutely poisonous, carcinogenic, mutagenic, and/or teratogenic. They also include heavy metals such as lead and mercury and are placed in the first category.
2. **Radioactive wastes:** They include elements and compounds that produce or absorb ionizing radiation and any material that interacts with such elements and compounds - such as the rods and water that moderate nuclear reactions in power plants.
3. **Medical wastes:** They are a broad category, spanning the range from tissues and fluids capable of harbouring infectious disease-causing organisms to the materials and containers that hold and transfer them.

Meanwhile, in the U.S, the EPA identifies two general hazardous waste categories: designated hazardous wastes and characteristic hazardous wastes. A designated waste, or listed hazardous waste, is one that is specifically listed by the U.S. EPA as hazardous. The main lists under this category include th
e:

- **F-List:** Wastes on this list are created from common manufacturing and industrial processes. Since these wastes are produced in multiple industries, they are known as "non-specific source waste".

- **K-List:** Wastes, including sludge or wastewater, from a selection of specific industries, such as petroleum refining or pesticide manufacturing, are included on this list. Since we know the industry they are produced in, they are called "source-specific wastes".
- **P-List and U-List:** Wastes on these lists are commercial chemical products being discarded in their unused form. They become hazardous when discarded. Acutely hazardous wastes fall under the P-List, while non-acutely hazardous wastes fall under the U-List.

On the other hand, a characteristic hazardous waste is one that exhibits any one of the characteristics of ignitability, corrosiveness, reactivity, or toxicity. The characteristic wastes are further classified based on the characteristic that makes it hazardous and they include:

- **Ignitable wastes:** The U.S. Federal government level defines an ignitable waste as any liquid with a flash point of less than 60 degrees Celsius, any non-liquid that can cause a fire under certain conditions, or any waste classified by the U.S. Department of Transportation (USDOT) as a compressed ignitable gas or oxydizer.
- **Corrosive wastes:** A corrosive waste is defined as any aqueous material that has a pH less than or equal to 2, a pH greater than or equal to 12.5, or any material that corrodes metals. An example is battery acid.
- **Reactive wastes:** A reactive waste is defined as one that is unstable, changes form violently, is explosive, reacts violently with water, forms an explosive mixture with water, or generates toxic gases in dangerous concentrations. An example is lithium–sulphur batteries.
- **Toxic wastes:** A toxic waste is one whose extract contains concentrations of certain constituents in excess of those stipulated by the U.S. Safe Drinking Water Act (SDWA).

(The hazardous waste identification regulations that define the characteristics of toxicity, ignitability, corrosivity and reactivity, as well as the tests for these characteristics, can vary.)

In addition to these classifications, the United Nations Environment Programme (UNEP) categorises hazardous wastes as 11 key substances/wastes. This list includes:

- **Arsenic** used in making electrical circuits, as an ingredient in pesticides, and as a wood preservative. It is classified as a carcinogen.

- **Asbestos** is a material that was once used for the insulation of buildings, and some businesses are still using this material to manufacture roofing materials and brakes. Inhalation of asbestos fibers can lead to lung cancer and asbestosis.
- **Cadmium** is found in batteries and plastics. It can be inhaled through cigarette smoke, or digested when included as a pigment in food. Exposure leads to lung damage, irritation of the digestive tract, and kidney disease.
- **Chromium** is used as brick lining for high-temperature industrial furnaces, as a solid metal used for making steel and in chrome plating, manufacturing dyes and pigments, wood preserving, and leather tanning. It is known to cause cancer, and prolonged exposure can cause chronic bronchitis and damage lung tissue.
- **Clinical wastes** such as syringes and medication bottles can spread pathogens and harmful microorganisms, leading to a variety of illnesses.
- **Cyanide** is a poison found in some pesticides and rodenticides. In large doses, it can lead to paralysis, convulsions, and respiratory distress.
- **Lead** is found in batteries, paints, and ammunition. When ingested or inhaled, it can cause harm to the nervous and reproductive systems, and the kidneys.
- **Mercury** is used for dental fillings and batteries. It is also used in the production of chlorine gas. Exposure can lead to birth defects and kidney and brain damage.
- **Polychlorinated biphenyls (PCBs)** are used in many manufacturing processes, by the utility industry, and in paints and sealants. Damage can occur through exposure, affecting the nervous, reproductive, and immune systems, as well as the liver.
- **Persistent organic pollutants (POPs)** are found in chemicals and pesticides, and may lead to nervous and reproductive system defects. They are some of the world's most dangerous chemical toxins which are commonly grouped into a collection called the "dirty dozen" by chemists and environmentalists. They can bio-accumulate in the food chain or persist in the environment and be moved great distances through the atmosphere.
- **Strong acids and alkalis** used in manufacturing and industrial production. They can destroy tissue and cause internal damage to the body.

Impacts:

Hazardous wastes can damage the environment by contaminating the air, water and soil. Once in the environment, hazardous wastes can affect all life forms. Whether through direct exposure or environmental damage, hazardous wastes present a risk to human health.

Toxic effluents such as those from improperly managed mining operations can have very serious effects on wildlife and pose serious threats to human health. Marine ecosystems and wildlife have also suffered major damage as a result of oil spills resulting from accidents to large ocean-going tankers.

Safety related properties of hazardous wastes include their tendency to corrode, explode, burn or cause chemical reactions. Safety effects resulting from hazardous wastes include injury and even death from an explosion, fire outbreak, chemical reaction or other hazardous situations created by such wastes.

Effects to property and the physical environment mainly pertain to property damage, which can also result from fires and explosions. These incidents, which result from improper hazardous waste management, may emit hazardous substances to the atmosphere as well, causing deleterious health effects, through inhalation for example.

Health related properties of hazardous wastes include their tendency to cause infections, irritations (mainly due to allergic response), mutations or other toxic or radioactive effects. Health effects from hazardous waste exposure occur after hazardous components enter the body through inhalation, skin absorption, ingestion, or puncture wounds.

Toxic wastes often contain carcinogens, and exposure to these by some route, such as leakage or evaporation from the storage, causes cancer to appear at increased frequency in exposed individuals. For example, a cluster of the rare blood cancer polycythemia vera was found around a toxic waste dump site in northeast Pennsylvania in 2008.

The health effects of hazardous wastes are dependent on the amount (doses), route and duration of exposure. Temporary health effects of hazardous waste exposure can include

dizziness, headaches and nausea, while prolonged exposure can also result in chronic illnesses, disabilities or death apart from cancer.

Hazardous wastes mainly from household waste sources are prone to easily cause health hazards due to their proximity to potential receptors. Wastes from other sources are further from the potential receptors so their exposure routes are longer. This results in the masking or delayed manifestation of exposure effects.

Some major incidents from across the global communities when hazardous wastes profoundly affected the environment and public health include:

1. **The decline in population of birds in the U.S. during the mid-twentieth century:**
   In the 1950s and 1960s, in the U.S., there was a dramatic decline in the populations of several predatory birds due to dioxin exposure. Dichlorodiphenyltrichloroethane (DDT) exposure was found to interfere with the calcium deposition in the eggshells of birds of prey, causing them to be thin and fragile and often to be crushed by the parents in the nest. One well-known species affected in this way was the Bald Eagle.

2. **The Minamata Disease:**
   Although limited cases of accidental poisonings, such as from the accidental ingestion of lead and household cleaners, occur daily throughout the world, one of the first high-profile episodes of mass poisonings affecting neighbourhoods and whole cities occurred in Minamata, Japan, in the 1950s.

   Many of the town's residents contracted mercury poisoning resulting from the Nippon Chisso Hiryo Co.'s manufacturing of acetaldehyde, and that material was later associated with the deaths of at least 3,000 people. Mercury from the production process spilled into the bay and entered the food chain, including seafood, which was the town's primary protein source.

   Deformed fish appeared in Minamata Bay, and townspeople exhibited strange behaviours, including trembling, stumbling, uncontrollable shouting, paralysis, hearing

and vision problems, and body contortions. In extreme cases, insanity, paralysis, coma, and death followed within weeks of the onset of symptoms.

This disease caused by severe mercury poisoning was later named as the Minamata Disease, after the place. While mercury was long known to be a toxin, it was Minamata that vividly highlighted its dangers in the food chain.

3. **The Love Canal Tragedy:**
   Hooker Chemical and Plastics Corporation used Love Canal, an empty canal in a section of the Niagara Falls, New York, in the 1940s and 1950s to dump 21,000 tonnes of toxic waste in metal drums. After the canal was filled, the land was given to the city, and houses and an elementary school were built on the site.

   Eventually, the chemical waste seeped into people's basements, and the metal barrels worked their way to the surface. Trees and gardens began to die; bicycle tires and the rubber soles of children's shoes disintegrated in noxious puddles. From the 1950s to the late 1970s, residents repeatedly complained of strange odours and substances that surfaced in their yards.

   By the late 1970s, the toxic chemicals had leaked through their drums and risen to the surface, resulting in high rates of birth defects, miscarriages, cancer and other illnesses, and chromosome damage. The neighbourhood was subsequently evacuated by September 1979 after an emergency was announced in that region.

4. **The 9/11 Attack:**
   The dust from the remains of the three World Trade Center buildings that were destroyed during the September 11, 2001, terrorist attacks in New York City were found to contain mercury, lead, dioxin, and asbestos. Aside from the dangers of breathing in toxic building materials, the attacks raised concerns about potential sabotage of toxic waste sites, such as storage facilities adjacent to nuclear power plants, or of the transport of such waste between sites. More than 15,000 chemical plants and refineries nationwide were also in danger, with more than 100 of them putting at least a million people at risk should an attack occur.

5. **Various Natural Disasters and Accidents:**
   The danger of a sudden release of toxic material also looms in the aftermath of extreme weather events, natural disasters, and accidents. Three Superfund toxic waste sites in and around New Orleans were flooded in 2005 by Hurricane Katrina, and toxic waste was found in debris deposited throughout the flooded area. People encountered toxins buried in the ground, in stream runoff, in groundwater that supplies drinking water, or in floodwaters.

   Similarly, the devastating Indian Ocean earthquake and tsunami of 2004 stirred up and dispersed vast amounts of toxic wastes – including radioactive waste, lead, heavy metals, and hospital wastes – across the Indian Ocean basin, and the tsunami that struck Japan in 2011, which caused the Fukushima nuclear accident, released tremendous amounts of irradiated water into the Pacific Ocean.

Some of the other numerous high-profile examples of hazards caused due to toxic wastes include the Exxon Valdez oil spill in 1989, the Chernobyl disaster in 1986, the Bhopal gas leak in 1985, and the Three-Mile Island scare in 1979.

Hazardous Waste Management:

One of the biggest problems with today's toxic material is how to dispose it properly. Historically, hazardous wastes were dumped into streams, rivers and oceans, or buried underground in landfills. Many hazardous wastes were loosely regulated, allowing substantial contamination of communities and the environment.

However, it is now important to handle hazardous waste with special precautions in designated facilities. Hazardous waste management helps us avoid toxic effects on the environment and ensure proper handling and disposal of hazardous wastes. The necessary management processes depend largely on the quantity, composition, and phase of the waste, which are functions of the waste-generating source.

Hazardous waste management includes waste avoidance, waste reuse and recycling, waste storage on the producer's premises, collection of waste from those premises (if required), transport (if required), interim storage (if required), secondary transport (if required), treatment and final disposal.

Each hazardous waste management scheme is unique because it is each designed uniquely to meet the specific needs of the manufacturing process that is used and the wastes that are generated. However, they all have similar key steps. These stages include:

1. **Minimising volume of hazardous wastes:**
   It is by far the most-effective method of hazardous waste management. The least expensive and easiest method for reducing the volume of hazardous waste is source separation, which keeps hazardous wastes from contaminating non-hazardous wastes.

   A more effective approach to waste reduction is substitution of raw materials with non-toxic or less toxic alternatives, such as oxygen for chlorine in the bleaching of wood. Toxins can also be reduced by efficient production processes, proper maintenance of machinery, and through "green chemistry" – a movement that seeks to build chemical products and processes that reduce or eliminate the need for toxic substances.

2. **Recycling:**
   Some hazardous wastes, such as expensive heavy metals, can be recycled into new products. When heavy metals go through the proper treatment, they could bind to other pollutants and convert them into easier-to-dispose solids, or they could be used as pavement filling.

   Such treatments reduce the level of threat of harmful chemicals, like fly and bottom ash, while also recycling the safe product. This can not only cut the amount of toxins needed in the production process but also the cost of production. Examples of products that can be recycled include lead–acid batteries and electronic circuit boards.

3. **Treatment:**

Hazardous waste can be treated by chemical, thermal, biological, and physical methods. Chemical methods include ion exchange, precipitation, oxidation and reduction, and neutralization. Among thermal methods is high-temperature incineration, which not only can detoxify certain organic wastes but also can destroy them. Special types of thermal equipment are used for burning waste in either solid, liquid, or sludge form. These include the fluidized-bed incinerator, multiple-hearth furnace, rotary kiln, and liquid-injection incinerator.

Biological treatment of certain organic wastes, such as those from the petroleum industry, is also an option. One method used to treat hazardous waste biologically is called landfarming. In this technique, the waste is carefully mixed with surface soil on a suitable tract of land. Microbes that can metabolize the waste may be added, along with nutrients. In some cases, a genetically engineered species of bacteria is used.

Toxic wastes may also be treated by using bioremediation processes, in which living organisms are added to the waste to degrade organically or transform contaminants or to reduce them to environmentally safe levels. Some microorganisms use oil as a source of food, producing compounds that can emulsify oil in water and facilitate the removal of the oil.

Successfully applied following the Exxon Valdez oil spill of 1989 and the Gulf of Mexico oil spill of 2010, bioremediation treats contamination in place, thus avoiding removal and disposal costs while reducing environmental stress associated with conventional cleanup efforts. A similar process, called phytoremediation, uses plants to draw in toxic substances, such as heavy metals, from soil.

The chemical, thermal, and biological treatment methods outlined above change the molecular form of the waste material. Physical treatment, on the other hand, concentrates, solidifies, or reduces the volume of the waste. Physical processes include evaporation, sedimentation, flotation, and filtration.

Yet another process is solidification, which is achieved by encapsulating the waste in concrete, asphalt, or plastic. Encapsulation produces a solid mass of material that is

resistant to leaching. Waste can also be mixed with lime, fly ash, and water to form a solid, cement-like product

4. **Disposal:**

Disposal of hazardous wastes are mostly done by either landfills or incineration based on the type of toxic waste generated.

In terms of hazardous waste, a landfill is defined as a disposal facility or part of a facility where hazardous waste is placed on land and which is not a pile, or a land treatment facility, a surface impoundment, an underground injection well, a salt dome formation, a salt bed formation, an underground mine, a cave, or a corrective action management unit.

Hazardous wastes may be sequestered in hazardous waste landfills or disposal facilities which are designed to permanently contain the waste and prevent the release of harmful pollutants to the environment. However, leaks may occur.

Meanwhile, organic hazardous wastes may be "destroyed" by incinerating them at a high temperature. Flammable wastes can sometimes be burned as energy sources. For example, many cement kilns burn hazardous wastes like used oils or solvents.

Today, incineration not only reduces the amount of hazardous waste, but also generates energy from the gases released in the process. It is known that this particular waste treatment releases toxic gases produced by the combustion of byproduct or other materials which can affect the environment. However, current technology has developed more efficient incinerator units that control these emissions to a point where this treatment is considered a more beneficial option.

There are different types of incinerators which vary depending on the characteristics of the waste. Incineration may be at low temperatures, primarily for urban refuse, or at high temperatures, which are best for many industrial wastes such as tar, paint, pesticides, and solvents since they prevent the formation of dioxins.

Starved air incineration is another method used to treat hazardous wastes. Just like in common incineration, burning occurs, however controlling the amount of oxygen allowed proves to be significant to reduce the amount of harmful byproducts produced.

Starved air incineration is an improvement of the traditional incinerators in terms of air pollution. Using this technology, it is possible to control the combustion rate of the waste and therefore reduce the air pollutants produced in the process.

Conclusion:

The journey of waste management is a long one. From the identification of problems and passing of related legislations to enforcing the laws and regulations to implementation of advanced waste management strategies and technologies around the world, the global waste management programmes have become better day by day.

To enforce hazardous waste management laws and strategies and to keep the environment and people safe from harmful substances and hazardous waste, a variety of global, regional and sub-regional treaties, accords and agreements like the Dumping Convention (1973), the Cairo Guidelines (1987) and the Basel Convention (1992) have been signed.

Uncountable number of grass-root level organisation, numerous government programmes and a diverse range of international organizations including the United Nations Environment Programme (UNEP), the European Union (EU), the World Bank, the United States Agency for International Development, and many other large waste disposal companies have been contributing to the safe management of hazardous wastes.

However, much work remains to be done to understand and mitigate the negative impacts caused by hazardous wastes. This work is especially critical today as new and potentially hazardous substances will continue to emerge. The global economy is generating increasing amounts of hazardous wastes in countries that lack the systems and resources for their proper management.

This waste poses serious risks to people and the environment and has the potential to contaminate other non-hazardous wastes and substances if it is not adequately controlled. Keeping the environment and people safe from harmful substances and hazardous waste goes beyond management. It is about working to avoid these dangers entirely by removing them, wherever possible, from production and use.

What if countries could reduce risks from exposures to harmful substances by implementing sound chemicals management at all stages of production, use and disposal? What if global and national agendas were driven by accurate, up-to-date information on the full costs and benefits of chemicals and waste products? And what if we could use the strong international agreements to address or eliminate the most harmful substances, supporting national action to protect our planet's environmental resources and secure the livelihoods and health of future generations?

Wouldn't it be wonderful?!

Wildlife Conservation in India

Introduction to Wildlife Conservation:

Wildlife resources constitute a vital link in the survival of the human species and have been a subject of much fascination, interest, and research all over the world. Today, when wildlife habitats are under severe pressure and a large number of species of wild flora and fauna have become endangered, the effective conservation of wild plants and animals is of great significance.

Because every one of us depends on plants and animals for all vital components of our welfare, it is more than a matter of convenience that they continue to exist; it is a matter of life and death. Being living units of the ecosystem, plants and animals contribute to human welfare by providing

- material benefit to human life;
- knowledge about genetic resources and their preservation; and
- significant contributions to the enjoyment of life (e.g., recreation).

Human society depends on genetic resources for virtually all of its food; nearly half of its medicines; much of its clothing; in some regions, all of its fuel and building materials; and a part of its mental and spiritual welfare. Considering the way we are galloping ahead, oblivious of what legacy we plan to leave for future generations, the future does not seem too bright. Genetic resources are treated as inexhaustible mineral resources, but we need to care about them. It is here that the concept of management and conservation of wildlife comes into play, because any living organism that is not human or undomesticated is 'wildlife'.

Wildlife conservation refers to the practice of protecting wild species and their habitats in order to maintain healthy wildlife populations and to restore, protect or enhance natural ecosystems.

Major threats to wildlife include:

- Overexploitation
- Culling
- Habitat destruction, degradation and/or fragmentation

- Climate change
- Pollution
- Illegal trading, hunting and poaching

According to a report, the population of wildlife animals has decreased by 68% since 1970 globally and we are near to the sixth mass extinction. The IUCN estimates that 35,000 species of the ones assessed are at risk for extinction.

Expanding to all existing species, a 2019 UN report on biodiversity put this estimate even higher at a million species. It is also being acknowledged that an increasing number of ecosystems on Earth containing endangered species are disappearing.

Wildlife conservation addresses all these threats by protecting wild species and the natural ecosystem. Many efforts have been taken by governments at both national and international levels to preserve Earth's wildlife.

These efforts include signing treaties, making legal reforms, enforcing laws, forming conservation programmes and more. Among the various methods, the signing of treaties, agreements and conventions is seen as one of the best ways to bring all the countries under the banner of wildlife conservation.

Implementing the idea, several treaties have been signed internationally to promote wildlife conservation. The 5 most prominent agreements amongst them, collectively known as 'The Big 5 International Wildlife Conservation Agreements', are:

1. **The Ramsar Convention on Wetlands of International Importance, 1971:** It provides the framework for the conservation and wise use of wetlands and their resources.
2. **The UNESCO World Heritage Convention (WHC), 1972:** It aims to protect natural and cultural heritage by protecting World Heritage sites.
3. **The Washington Convention or the Convention on International Trade in Endangered Species (CITES), 1973:** It is an international agreement between governments that establishes protection for over 35,000 species of flora and fauna in the scope of international wildlife trade.

4. **The Bonn Convention or the Convention on Migratory Species (CMS), 1975:** It is an international environmental treaty signed under the United Nations Environment Programme (UNEP) that acts as a global platform for the conservation and sustainable use of migratory animals and their habitats.
5. **The Rio Convention or the Convention on Biological Diversity (CBD), 1992:** It aims to enhance the conservation of biological diversity and the sustainable use of the earth's resources.

There are also numerous nongovernmental organizations (NGO's) dedicated to wildlife conservation on the international level such as the International Union for Conservation of Nature (IUCN), World Wildlife Fund (WWF), Nature Conservancy, and Conservation International.

Wildlife Conservation in India:

A great wealth of biological diversity exists in India's forests, mountains, plains, plateaus, wetlands and marine areas. The people of the Indian subcontinent are blessed with some of the most profuse natural gifts: verdant forests, water-stocked Himalayan ranges, rich coastal fish resources, productive estuaries, grassy pastures, and bountiful river systems.

Abundant rainfall and fertile soils add to this plentitude. Our megadiverse country with only 2.4% of the world's land area, accounts for 7-8% of all recorded species, including over 45,000 species of plants and 91,000 species of animals. Four of 34 globally identified biodiversity hotspots – The Himalayas, the Western Ghats, the North-East, and the Nicobar Islands – can be found in India.

However, years of mismanagement have degraded our forests, wounded our coastline, and poisoned our aquifers with devastating results. Today, India contains 172 species (2.9% of the world's total number) of animals that are considered to be globally threatened by the IUCN. These include 53 species of mammals, 69 species of birds, 23 species of reptiles, and 3 species of amphibians.

These threats to the wildlife and the endangered species of plants and animals in India calls for their conservation. Thus, wildlife conservation has now become a major area of concern in India.

Wildlife conservation in India has a long history, dating back to the colonial period when it was rather very restrictive to only targeted species and that too in a defined geographical area. Then, the formation of the Wildlife Board at the national level and enactment of the Wildlife Act in 1972 laid the foundation of the present day 'wildlife conservation era' in post-independent India.

Currently, India is a part of several flagship programmes and treaties for wildlife conservation. The Government of India has adopted several measures for wildlife conservation in India. They include:

1. **Legal Provisions:**
   In India, there are various laws that provide for the conservation of wildlife, as well as overall biodiversity. The chief among them is the Wildlife Protection Act, 1972 which was implemented with the objective of protecting our wild animals, birds and plants.

   Fisheries Act 1897, Indian Forests Act 1927, Prevention of Cruelty To Animals 1960, Water (Prevention and Control of Pollution) Act 1974, Forest Conservation Act 1980, Air (Prevention and Control of Pollution) Act 1981 and Environment Protection Act 1986 and Biological Diversity Act 2002 are a few among the many other acts passed by the government to protect wildlife.

   Further, a Wildlife Crime Control Bureau has been set up to curb illegal trade or smuggling of endangered species in the country. There are many constitutional provisions protecting the environment. Under Article 51 A(g), the Constitution of India states that it is a fundamental duty of the citizens to protect wildlife and have compassion for living creatures thus guaranteeing the protection of wildlife.

   In addition to this, Article 48 A also puts an obligation on the state to protect, safeguard and work for the improvement of forests and wildlife of the country. The

subjects relating to the protection of wildlife are enlisted under the concurrent list of the Constitution of India, i.e. Schedule VII List III. This depicts that both the Union and the State Governments are empowered to make laws on this subject.

At the Central Government level, the Union Ministry of Environment, Forest and Climate Change is responsible for all matters dealing with policy on wildlife conservation. While at the State Government levels, the Forest Departments under their control implement the national policies. The Wildlife Wing in the Ministry of Environment, Forest and Climate Change, is headed by the Director, Wildlife Preservation, who is also designated as the Additional Director General of Forests (Wildlife) to the Government of India.

The Wildlife Wing has three Divisions, namely, Project Tiger Division, Project Elephant Division and Wildlife Division, each headed by an officer designated as Inspector General of Forests. These three Divisions look after national policies and projects, international coordination, Centrally Sponsored Schemes and State level implementation of activities relating to the conservation of wildlife in Tiger Reserves, Elephant Reserves, national parks and wildlife sanctuaries of India, wildlife laws, International Conventions and Treaties, matters relating to zoos, wildlife conservation, international trade in wildlife and wildlife articles, research, capacity building, major policy interventions, court cases, Parliament related matters, budget, besides a host of other related matters.

Two autonomous wildlife organizations, the Wildlife Institute of India and the Central Zoo Authority, are under administrative control of the Wildlife Wing. The Wildlife Institute of India is an academic institute recognized as one of the Centres of Excellence in the country. Meanwhile, the Central Zoo Authority is the statutory authority for the recognition and technical development of the zoos in India.

2. **Collaboration with International Efforts:**
   India is a member of all major international conservation treaties and commissions related to habitat, species and environment. They include the:
   a. Ramsar Convention, 1971

b. UNESCO World Heritage Convention (WHC), 1972
c. Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), 1973
d. Convention on Migratory Species (CMS), 1979
e. Convention on Biological Diversity (CBD), 1992
f. South Asia Wildlife Enforcement Network (SAWEN), 2011
g. Wildlife Trade Monitoring Network (TRAFFIC)
h. United Nations Forum on Forests (UNFF)
i. International Whaling Commission (IWC)
j. International Union for Conservation of Nature (IUCN)
k. Global Tiger Forum (GTF)

3. Development of Protected Area Systems:

The government of India has allotted vast spaces of green forests for wildlife to flourish in. Several lands are decreed as protected areas meant for the sole purpose of protecting wildlife against human interference. These areas are used for in situ conservation, which involves conservation of species in their natural habitat.

The first national park in India was established in 1936 as Hailey National Park, now famous as the Jim Corbett National Park, Uttarakhand. Since Independence, there has been a steady rise in the number of Protected Areas (PAs), especially after the enactment of the Wildlife Protection Act in 1972.

India has the following kinds of protected areas, in the sense of the words designated by IUCN:

a. National parks:
   They are IUCN category II protected areas, within a sanctuary or not, that can be notified by the state government as a National Park, by reason of its ecological, faunal, floral, geomorphological, or zoological association or importance, needed to for the purpose of protecting & propagating or developing wildlife there in or its environment. Usually, no human activity is permitted inside the national park.

b. Wildlife sanctuaries:
   They are IUCN Category IV protected areas of importance for flora, fauna, or features of geological or other interest, which is reserved and managed for conservation and to provide opportunities for study or research.

c. Biosphere reserves:
   The Indian government has established 18 biosphere reserves to protect larger areas of natural habitat than a typical national park or animal sanctuary, and that often include one or more national parks or reserves, along with buffer zones that are open to some economic uses.

d. Reserved and protected forests:
   These are forested lands where logging, hunting, grazing and other activities may be permitted on a sustainable basis to members of certain communities. In reserved forests, explicit permission is required for such activities, while in protected forests, such activities are allowed unless explicitly prohibited.

e. Conservation reserves and community reserves:
   They are protected areas of India which typically act as buffer zones to or connectors and migration corridors between established national parks, wildlife sanctuaries and reserved and protected forests of India.

f. Private protected areas:
   They are protected areas inside India whose land rights are owned by an individual or a corporation/organization, and where the habitat and resident species are offered some kind of protection from exploitative activities like hunting, logging, etc.

g. Conservation areas:
   They refer to well-demarcated large geographical entities with an established conservation plan, and were part of a joint Indo-US project on "landscape management and protection".

4. **Recovery, Relocation and Rehabilitation of Endangered species:**
   There are a number of species of fauna and flora, listed under Schedule I of the Wildlife (Protection) Act, 1972, which are critically endangered. They need to have special recovery plans prepared to ensure their recovery and to prevent extinction, local or total.

   Under these individual plans, which need to be revised every five years or so, the prevalent status and distribution of the species, its coverage under the PA system and which prominent habitats are left out of it, the threats, etc., would be assessed. Species covered under special projects like Project Elephant, etc., need not have such recovery plans.

   Meanwhile, relocation and rehabilitation of species is done mainly for three reasons. Firstly, to translocate excess or troublesome individuals and groups of species, secondly, to reintroduce species locally made extinct or to augment populations rendered critically low, and thirdly, to rescue temporarily displaced individual wild animals.

5. **Species Specific Enforcement Operations:**
   The Government of India has initiated various species specific enforcement projects to protect wildlife in the country. Some main projects include:
   a. Project Tiger:
      It is a centrally sponsored scheme launched in 1973 in Palamau Tiger Reserve, Jim Corbett National Park, Uttarakhand for the conservation of Royal Bengal Tigers in the Indian subcontinent. The National Tiger Conservation Authority is constituted for this project. The program started with 9 Tiger reserves but it has now substantially grown to fifty reserves.

   b. Project Elephant:
      It is also a centrally sponsored scheme and launched in 1992 to take action against the declining populations and disturbed migration of Asiatic elephants. It was implemented in 16 states to protect elephants from poaching and to oversee clearance of migratory paths. Under this, 88 Elephant corridors were set up. The Haathi Mere Saathi scheme was also launched by the Ministry of

Environment, Forest and Climate Change in partnership with wildlife trust of India.

c. Project Snow Leopard:
It was launched in 2009 with an objective to encourage inclusivity and a participatory approach for the conservation of Snow Leopards. This initiative was started with the combined efforts of the Global Snow Leopard and Ecosystem Protection Program. The Government also launched the 'First National Protocol on Snow Leopard Population Assessment' in the year 2019, which encompasses the use of technology such as camera traps and scientific surveys.

d. Project Hangul:
In the 1970s, the Jammu and Kashmir Government in collaboration with the International Union for Conservation of Nature (IUCN) and World Wildlife Fund (WWF) designed a project for the conservation of the Kashmir Red Stag and its habitat. This project came to be known as Project Hangul.

e. Crocodile Conservation Project:
This project is yet another successful venture by the Government of India that was introduced in 1975 to conserve the Indian Crocodiles – Gharials, Muggers, and Saltwater Crocodiles – who were on the verge of extinction. The main objectives of the crocodile project is to protect the remaining population of crocodiles and their natural habitat by establishing sanctuaries; to promote captive breeding; to improve management; and to involve the local people in the project intimately.

f. Project Dolphin:
Recently, on the occasion of the 74th Indian Independence Day, 15 August 2020, the Indian Ministry of Environment, Forest and Climate Change announced 'Project Dolphin' to boost conservation of both river and oceanic dolphins. The project aims to protect the dolphins from major threats like river water pollution, poaching and siltation.

g. Sea Turtle Project:
This project was launched in 1999 by the Ministry of Environment, Forest and Climate Change in collaboration with UNDP to conserve the vulnerable Olive Ridley Turtle that visits India during Winter. With the Wildlife Institute of India as the implementing agency, this project has contributed towards the development of guidelines to safeguard the turtle population, and reduce the turtle mortality rate and for tourism in sea turtle areas.

Apart from these projects, the Government of India has also been handling projects like Operation Save Kurma, Operation Turtshield, Operation Lesknow, Operation Clean Art, Operation Softgold, Operation Birbil, Operation Wildnet, Operation Freefly, Operation Wetmark, Vulture Conservation and Indian Rhino Vision (IRV) 2020.

6. Captive Breeding and Gene Banks:

Captive breeding is the selection of a particular wild species and breeding them in an artificial condition under the supervision of experts. This method is perceived as the last chance to preserve a species in the wild.

Many species have been saved from extinction by captive breeding in Zoological Parks of India. Captive breeding program in India is taken care by Central Zoo Authority of India for endangered species as per the National Zoo Policy. The Central Zoo Authority (CZA) has identified about 70 endangered species for captive conservation breeding.

They include Asiatic Lion, Indian Rhinoceros, Sangai Deer, Red Jungle Fowl, the Royal Bengal Tiger, Gangetic Dolphin, Lion-Tailed Macaque, Gangetic Gharial, Crocodile, several species of Snakes, and critical vulture species like long-billed vulture, Egyptian vulture and Indian vultures.

On the other hand, gene banks are a type of biorepository that preserves genetic material. In an effort to conserve biodiversity, gene banks are used to store and conserve the genetic resources of endangered species and their wild relatives. This stored genetic

material can later support cloning or resurrection of the species that may have gone extinct.

7. **Restoration Ecology:**
   Restoration ecology is the scientific study supporting the practice of ecological restoration, which is the practice of renewing and restoring degraded, damaged, or destroyed ecosystems and habitats in the environment by active human interruption and action.

   During the last 100 odd years, massive plantations of exotic trees have taken place, all over India. Sometimes, prime forests were cut down to plant fast-growing, commercial timber and fuelwood trees. However, during the last 10 years, the Forest Department has stopped or curtailed growing such exotics in protected areas.

   There are many protected areas where these exotics or introduced species have matured and are ready for harvesting – for example, teak and eucalyptus in Dudhwa National Park in Uttar Pradesh, eucalyptus, pine and Acacia mearnsii in Mukurthi National Park in Tamil Nadu, teak again in Buxa tiger reserve, etc. – but due to the national park status of the sites, the State Forest Departments have not harvested them.

   At the same time, trees growing outside forests (TOFs), including farm forestry, play a more important role in meeting national timber requirements than government forests. This practice, which is a part of the ecology restoration programmes, has greatly helped conserve forests and wildlife.

Along with the above mentioned governmental efforts, several non-governmental bodies have stepped up to the demands of wildlife conservation in India as well. Activism against poaching, encroachment of forest land and habitat destruction is a common phenomenon in modern India.

There are several volunteer groups and corporations that take initiative towards maintaining undisturbed environments for flora and fauna to flourish in. Some NGOs in the forefront at the wildlife conservation in India include:

1. **World Wildlife Fund, India (WWF India):**
   Almost synonymous with wildlife conservation throughout the world, WWF India has been leading the charge of preservation, conservation, and support for more than 50 years. The approach taken by the organization to battle India's diverse and complex nature conservation is strongly backed by science. The WWF works with governments, corporates, businesses, NGOs, schools and education institutions and the society at large, supporting and raising awareness about endangered ecosystems.

2. **Wildlife SOS:**
   Wildlife SOS is one of the premier NGOs in India for wildlife conservation. Started in 1998, it began with an objective to protect India's biodiversity wealth in conjunction with the indigenous communities of India. The NGO is currently on a mission to save endangered species and at-risk livelihoods among the onslaught of the pandemic through various fundraisers.

3. **Wildlife Protection Society of India:**
   Founded by Belinda Wright in 1994, Wildlife Protection Society of India aims at focussing energy and knowledge to help tackle India's growing wildlife and nature crisis. The organisation also endeavours to reduce human-animal conflict, especially between humans and tigers, leopards, and elephants through directed community efforts.

4. **Nature Conservation Foundation:**
   Founded in 1996, NCF focuses on wildlife research and conservation, working across various wildlife habitats from coral reefs and tropical rainforests to mountainous forests of the North. The organisation also makes it a point to work with local communities in their habitats by supporting their training, livelihoods, and development programmes.

5. **Centre for Wildlife Studies:**
   A pioneering organisation for conservation, protection and scientific education of wildlife in India, Centre for Wildlife Studies was established in 1984. As a part of its efforts, the organisation undertakes various activities including educating those living near forest areas about wildlife and the need to safeguard the forests. The organisation

has adopted a scientific approach towards the preservation and betterment of forests and wildlife.

6. **The Wildlife Trust of India (WTI):**
   It is an organisation that is committed to conserve wildlife and preserve their habitats. They are a family of over 150 professionals consisting of conservation biologists, scientists, sociologists, wildlife veterinarians, managers, lawyers, finance experts, and communication specialists who run about 44 projects in India through their 'depth' and 'breadth'. While their 'depth' projects focus on the conservational challenges of a specific area, their 'breadth' projects address issues not limited by geographical boundaries like training forest staff and preventing accidental wildlife deaths.

7. **Sahyadri Nisarga Mitra (SNM):**
   SNM is a non-government organization in India, that focuses on the conservation of the rare Indian Pangolins in the Konkan areas, along with other initiatives including the Marine Turtles and bird conservation projects. Through their various activities, SNM aims to boost its conservation efforts by involving local communities for effective protection of wildlife, especially the Indian Pangolin.

Some of the other renowned NGOs in India include The Bombay Natural History Society (BNHS), Aaranyak in Guwahati, Rhino Foundation for Nature in Assam, Wildlife Society of Orissa, Friends of Forests in Maharashtra, Nature's Beckon in Assam, North Eastern Society for Preservation of Nature and Wildlife in West Bengal, Nature Conservation Society of Amravati in Maharashtra, Bali Nature and WildLife Conservation Society in West Bengal and The Friends of the Doon in Uttaranchal.

Challenges in Effective Implementation of Wildlife Conservation in India:

The exploitation of wildlife for trade and other benefits of humans have resulted in enacting and enforcing various legislations and Acts in almost all the countries of the world. India is also not untouched with this as it is a country with rich biodiversity. The laws enacted with the objective of protecting and conserving wildlife have strict provisions but despite these laws, the exploitation of wildlife resources and their illegal trade continues.

The hunting, poaching of animals and uprooting of trees, using of various endemic species of plants for various purposes have led to the threat of extinction and loss of biodiversity in the country. Although the Wildlife Protection Act, Customs Act, and Import-Export policies in India have provisions in regulating the conservation measures and trade of wildlife species, especially the endangered species, the illegal hunting and poaching activities and trade is still flourishing and the endangered species are still exploited.

Further, the Wildlife Protection Act does not cover the foreign endangered species of plants and animals and hence does not have the authority to protect such foreign species if they are being hunted or poached or used. It is noticed that the punishment and penalties for offences made under the Act is not enough to stop and control exploitation of wildlife.

The offenders are still able to get away by paying fines and those who are fighting cases are also not bothered since the cases in the Indian Courts are resolved very slowly. Since the verdict by the courts in such cases takes an average of 10 years, the offenders flourish in their activities and the exploitation of wildlife continues during the time.

There is another problem identified that the Forest departments and the Forest Officers are not able to work effectively in implementing the laws and facilitate the conservation activities because they are not adequately trained or have adequate resources. It is seen that the enforcement mechanism of the laws in India for the conservation and protection of wildlife is also complicated in nature.

The laws, on one hand, enable the forest officers to protect the forest's resources, but they are not given any powers to make policies pertaining to the situation which further creates problems in the confiscation of the felled timber or the poached animal. This has further helped in increasing exploitation.

On the other hand, the forest department itself plays a role in the exploitation activities for their selfish reasons and corruption. It has been noticed that the forest officials have never involved the local people residing in the surrounding places to stop the exploitation of wildlife

despite the fact that these people can actually help in preventing the exploitation and protecting the wildlife resources.

Recently, a new problem has come into the notice of environmentalists, NGOs and Law keepers concerned with the protection and conservation of wildlife. This issue pertains to the killing of many birds, listed in the Schedule I of the Wildlife Protection Act, 1972, due to human recreation of flying kites.

Many birds listed in Schedule I are killed by the threads, called as 'manja' locally, which is used for Kite flying, especially the Chinese thread. In spite of the imposed ban on the use of Chinese thread for kite flying under Section 5 of the Environment (Protection) Act, 1986, it is still in use among the people. This has killed quite a number of birds which are endemic to this country while some of these birds belong to migrating species.

Alongside all these, there also exists several other challenges that stem from lack of knowledge and awareness among people about the importance of wildlife protection. This in turn affects the effective implementation of wildlife conservation laws and programmes in the Indian community.

Possible Solutions for Better Implementation of Wildlife Conservation in India:

Though the pertaining to the protection of wildlife and their natural habitat enacted and enforced in India provides strict legal provisions for the very cause of wildlife protection and conservation, it is still observed that the ground reality is not the same.

The wildlife is still exploited; the animals are still hunted and traded for human benefits. Even the use of harmful substances in industries, daily activities of man, construction of roads and buildings, leisure and entertainment activities causes adverse effects on the environment which in turn affects the wildlife and their natural environment. Illegal hunting and trade of wildlife are still taking place in India without abiding by the norms of these laws.

Thus, a strong need for awareness of wildlife protection and conservation among the public is required and effective & strict implementation of these laws needs to be done by every state. All

the problems pertaining to wildlife protection and conservation needs to be addressed strictly adhering to the law and finding some alternative solutions too so that the wildlife could be protected and conserved.

To stop the criminal and illegal activities of exploitation of wildlife resources in India, some stronger measures are required to be introduced. These measures could be in many forms. Some of them include:

1. **Stricter Government Action:**
   The government needs to be alert and watchful about the activities of humans, including research activities in reserves and protected areas. The government should make stricter provisions of punishment also if the laws are violated and wildlife is harmed.

   The Central Government as well as the State Governments should work together in coordination to protect the biodiversity of India. They should work with one another to maintain all biosphere reserves and protected areas and oversee that the officials deputed in these areas are working in consonance with the legal provisions and regulations. The governments are required to keep vigilance on the effective implementation of wildlife protection laws and conservation at all levels.

2. **Awareness among Public and Officials:**
   Towards the objective of protecting and conserving wildlife, there is a need to provide more awareness among the forest and other government officials who are deputed in the protected areas and reserves. These concerned personnel should be provided with all the required training and research in wildlife conservation measures and the legal provisions available for their protection.

   There is also a need to involve the local people who live in the surrounding areas of the protected areas by sensitising them about the importance of wildlife conservation and protection and the relevant laws governing it. The local people should be apprised of all the available provisions of laws in protecting and conserving the wildlife and the threatened species.

They should also be informed about the penalty and punishment in case of violation of any laws and harming the wildlife. This will help in an increased awareness among the local people which will further help in providing support to the forest officials who are working in these protected areas as well as the government officials.

3. **Recognizing and involving more NGOs:**
   The Non-Governmental Organizations (NGOs) play an important role in the protection and conservation of wildlife with the help of their initiatives. They work towards providing information and support to the authorities of the government concerned with wildlife protection and conservation so as to fight illegal trade of wildlife and poaching of wild animals. The support and involvement of more and more NGOs will greatly help in protecting the wildlife resources in India.

4. **Increasing Resilience of Nature Reserves:**
   This strategy includes maintaining natural reserves, creating buffer zones, minimization of human activities such as construction of buildings, roads and transportation activities, minimization of wildlife tourism, minimization of habitat fragmentation, conservation of genetic diversity, protection of biodiversity 'hot spots' thereby preventing extinction and protecting threatened species.

   Creation of buffer zones around fragmented landscapes is important in maximizing resilience. Areas protected by buffer zones also require restoration for which it focuses on reduction of specific impacts of climate change. There are some ecosystems which have intact landscapes and may have sufficient resilience but the use of land and water by the people residing in these regions needs to be controlled in a manner so as to prevent loss of resilience. Management of vegetation within these reserves also helps in maintaining resilience.

   More such strategies need to be implemented by the government in areas wherever wildlife and endangered species are in threat. The government also needs to have controlled wildlife tourism in these natural reserves and buffer zones. Wildlife tourism has adverse effects on the breeding and feeding pattern, disturbing the nesting sites and thus the government is required to have a proper vigilance on these activities and strictly

ensure that the rules and regulations under the relevant Acts and legislations are followed by the forest officials and concerned persons.

This strategy, if correctly followed, will prove to be very beneficial towards protection and conservation of wildlife and maintenance of wildlife in their natural habitat.

Apart from these solutions, for a better wildlife conservation strategy, various stakeholders suggest that:

- There needs to be an assessment of the extent of livelihood dependence of local communities and their contribution to ecosystem and wildlife conservation.
- The area of Protected Areas must be at least 5% of the geographical area of the country.
- The rights of the people in Protected Areas must be settled in a time bound manner.
- Biodiversity conservation must be looked after by the forest department at the central as well as State level, in coordination with other agencies.
- A separate wing of the Forest Department should look after the management and protection of wildlife.
- Silviculture in PAs should aim not only at forest protection but also at augmenting herbivore food and habitat enhancement.
- Changing crop patterns around PAs will minimize man-animal conflicts.
- Periodic review is needed of the list of the animals in the different schedules of the Wildlife Protection Act. The species may be added or deleted on the basis of review.
- In view of rising Protected Area-people conflicts, a third party arbitration mechanism may be explored.

Conclusion:

Wildlife protection and conservation is a huge task in India with the growing concerns of illegal trade and exploitation of wildlife resources. This objective cannot be achieved until and unless all branches of the government authorities, villagers & local people residing in and around the protected areas, non-profit and nongovernmental organizations, law enforcement officers and the general public work together towards this goal.

India has a rich heritage and is gifted with natural resources which are precious and endemic to the country and thus makes it a biodiversity rich country. Hence, there is a need for everyone to protect this rich resource and maintain a balanced environment. The need for effective strategies and solutions for the protection of wildlife in India and conservation of wildlife is the need of the hour.

The government must work in accordance to the present needs and demands in a situation when these wildlife species are threatened and many of which have come to the verge of extinction. The state governments and central government are required to work together and implement all the relevant laws and conservation strategies.

It can be concluded that: Although we(India) have started our journey of wildlife conservation years back, we still have a very long way to go!

Panthera tigris: An Endangered Species

Tigers:

The tiger or *Panthera tigris* is the largest member of the cat species and is also a member of the genus Panthera. It is rivaled only by the lion or Panthera leo in both strength and ferocity. It is most recognisable for its dark vertical stripes on orange-brown fur.

Tigers are apex or top predators. It is terrestrial and generally a solitary but social predator which requires large areas of habitat that supports its requirements for prey and rearing of its offspring.

Tigers are one of the most recognisable and popular of the world's charismatic megafauna. They were featured prominently in ancient mythology and folklore. They continue to be depicted in modern films and literature.

They appear on many coats of arms, flags and as mascots for sporting teams. The tiger also is the national animal of several countries including Bangladesh, Malaysia, South Korea and last but not the least India.

The origin of the word tiger is believed to have originated from the Persian word ‘tigra’ meaning 'pointed or sharp’ and the Avestan word ‘tigrhi’ meaning 'arrow', perhaps referring to the speed of the tiger.

It is also believed that the Middle English ‘tigre’ and Old English ‘tigras’ were derived from the Old French ‘tigre’, from Latin ‘tigris’ and that in turn was a borrowing from the Classical Greek word τίγρης (tigris).

The generic name Panthera however was derived from the Latin word ‘panthera’, the Ancient greek word πάνθηρ (panther) and the sanskrit word पाण्डर (Pand-ara) meaning ‘pale yellowish white’.

Subspecies of Tiger:

In 1758, Carl Linnaeus described the tiger in his work Systema Naturae Following and after his first descriptions of the species, several tiger specimens were described and were proposed to be subspecies. In 1999, the validity of several tiger subspecies was questioned.

Most potential subspecies described in the 19th and 20th centuries were differentiated on the basis of fur length and colouration, striping patterns and body size. Tigers from different regions vary little morphologically. It is considered that the gene flow between the different populations would have been possible during the Pleistocene.

It was therefore proposed to recognize only two tiger subspecies as valid and they were *Panthera tigris tigris* (P. t. tigris) which belonged to mainland Asia, and *Panthera tigris sondaica* (P. t. sondaica) from the Greater Sunda Islands.

After the craniological analysis of 111 tiger skulls from Southeast Asia, some new similarities and differences between different tiger populations were found. With respect to the results, a proposal to classify Sumatran and Javan tiger as distinct species, *P. sumatrae* and *P. sondaica* with Bali tiger as subspecies *P. sondaica balica* was made.

However, in 2015, ecological, morphological and molecular traits of all tiger subspecies were analysed in a combined manner. The results of this study showed only two evolutionary groups of tigers.

The authors, hence, proposed recognition of the two subspecies, namely *P. t. tigris* comprising the Indochinese, South Chinese, Bengal, Malayan, Siberian and Caspian tiger populations , and *P. t. sondaica* comprising the Javan, Bali and Sumatran tiger populations.

Even though the Bali tiger, Javan tiger and Capsian tiger are extinct, these nine subspecies are currently regarded as the subspecies of tigers.

The Siberian or Amur tiger is the largest of all subspecies and the Indian or Bengal tiger is the most numerous and accounts for about half of the total tiger population.

Description of Tigers:

Tigers have a muscular body, powerful forelimbs, a large head and a tail which is almost as long as half the length of their bodies. Their fur is dense and heavy. The fur's colouration varies between shades of orange and brown with white ventral areas and distinct vertical black stripes. These stripes are unique for each individual.

The stripes help the tiger to camouflage in vegetation and the tigers are one of the few striped cat species. The orangish colour of the tiger also helps it to camouflage as most of its prey are dichromat who will perceive the cat green and blend with the vegetation.

The tiger's coat pattern is seen even after it is shaved off and this is so because the pattern is caused due to stubbles and hair follicles and not pigmentation. The tigers also have a mane-like growth of fur around their neck and jaws along with long whiskers.

Their pupils are circular and irises are yellow. They also have small and rounded ears with a white spot that is significant for intraspecific communication on the back. The tigers have skulls which are similar to the ones of a lion and have fairly stout teeth. Their canines that are curved to a certain extent are the longest among all the living felids.

However, there are some other colour variations of tigers due to some specific genetic markers. There are three main variants, namely white tigers, golden tigers and stripeless snow white tigers. These variants now rarely occur due to reduction of tiger populations.

The white tiger has white fur, sepia brown stripes and blue irises. It has white fur due to lack of pheomelanin which causes the orange pigmentation. The golden tiger has a pale golden fur with a blond tone and reddish-brown stripes and the snow white tiger has white fur with extremely faint stripes and a pale reddish-brown ringed tail.

Apart from these three variants there is also one variant known as the black tiger and these tigers have thick black stripes which are so close together that the background color is very barely visible.

There is a notable difference in size between male and female tigers. The males prove to be larger than females. Generally, males grow to become 8.2 ft to 12.8 ft long, and weigh between 90 and 300 kg while the females grow to become 0.8 ft to 1.04 ft long and weigh between 65 kg and 176 kg. In both males and females, the length of the tails are between 0.6 m to 1.1 m of the total body length.

While the tigers of the Sunda islands are smaller and less heavy, rarely exceeding142 kg in weight, the Bengal and Siberian tigers are one of the tallest cats in shoulder height and are also amongst the biggest cats that have ever existed by reaching weights of more than 300 kg. Hence, it is said that the tigers from the south are much smaller than those of the north.

Distribution and Habitat of Tigers:

The tiger historically ranged widely from the Eastern Anatolia Region to Amur river basin and from foothills of himalayas to Bali in the Sunda Islands. They lived from eastern Turkey and Transcaucasia to the coast of the Sea of Japan, and from South Asia across Southeast Asia to the Indonesian islands of Sumatra, Java and Bali.

Currently, tigers have lost a minimum of 93% of their historic range and live in less than 6% of their historic region. They are no longer found in the islands of Java and Bali, Southwest and Central Asia and large parts of Southeast and East Asia. It now mainly occurs in the Indian subcontinent, Indochinese Peninsula, Sumatra and Siberian forests in the Russian Far East.

Tigers are essentially associated with the forest habitats and thrive in places where populations of wild cervids, bovids and suids are stable. The tiger has adapted to a great variety of habitats.

From the Siberian Taiga where nights are as cold as -40°C, to the mangrove swamps of the Sundarbans where temperatures reach up to 40°C, from coastal regions to mountains, from riverine forests to hilly, lowland forests and pine and temperate broadleaf and mixed forests, every place is home sweet home for tigers.

Lifestyle, Hunting and Diet of Tigers:

Tigers usually are diurnal when they are ot disturbed by humans. Having evolved in the temperate and subtropical forest of Eastern Asia, tigers are less tolerant to heat than other larger cats. Therefore, tigers are strong swimmers and like bathing in streams and lakes to escape from the heat and too. Tigers do not climb trees often but when under stress they climb trees.

The tigers are long-ranging species and these big cats disperse over distances up to 650 km. Tigers in the cold northern region tend to have larger territories than those in the south. The big cats use scent marking to communicate with other individuals in their range. The scratching posts also prove to be useful for communication along with keeping their claws sharp.

Like other Panthera, tigers also roar. There are two different roars, namely true roar and coughing roar. The true roar is made forcefully with an open mouth and can be heard up to 3km while the coughing roar is shorter and harsher and made with the mouth open and teeth exposed.

When tense, the tigers also moan. This is similar to a roar but more subdued and made when the mouth is partially or completely closed and this can be heard up to 400 m. They also snort softly in low frequency in friendly situations and this is known as chuffing. Grunts, woofs, snarls, miaows, hisses and growls are other vocal communications of the tiger.

In the wild the tigers have a life span ranging between 10 and 15 years. They spend most of their lives living and hunting alone and as solitary animals, tigers establish their own territories but have much larger home ranges where they roam around. They restrict their movement within their home range and satisfy their need within their range.

Generally, male tigers are more intolerant of other males than females are of other females. The territory disputes are usually solved by displays of intimidation and not outright aggression. However, confrontations do occur and sometimes result in injury and even death.

Spacing between individuals and maintenance of territories are achieved through scrapings on the ground, vocalization, fecal deposits, scent deposited by the rubbing of facial glands, claw marking of trees, and spraying of urine mixed with scent secreted from the anal glands.

Scent marking also announces the readiness of a tigress to mate. The tigers mate all round the year, with cubs being born after a gestation period of 93 to 114 days. The normal litter size is two to four and rarely as many as six. The cubs are born blind. They open their eyes six to fourteen days after their birth and even if their eyes are open, opacity prevents them from having a clear vision initially.

The cubs' milk teeth break at the age of about two weeks and they start eating meat at the age of eight weeks. They also make short ventures with their mother during this time but do not travel with her as she roams her territory until they are older. The males usually do not participate in raising the cubs but it has been recorded in some extremely rare cases.

When the cubs are weaned, they start to accompany their mother on territorial walks and are taught how to hunt. The cubs remain with the mother until about two years and they are nearly adults who have the ability to kill for themselves. However, they grow until the age of five.

Each litter has a dominant cub, usually a male cub, who is more active than the other siblings and takes the lead in their play. This sibling usually is the first to leave the mother. Young female tigers first establish themselves in their mother's territory and then move away with time but young male tigers migrate further away and set out to establish their territory.

In captivity, adult tigers are given 3kg to 6 kg of meat to eat per day. In the wild, tigers mostly feed on medium and large-sized mammals, especially the ungulates with a weight between 60 kg and 250 kg. Sambar deer, Manchurian wapiti, barasingha and wild boar are most preferred prey.

Tigers have the potential to take down larger prey but opportunistically they also feed on smaller prey like monkeys, peafowl, ground-based birds, hares, porcupines and even fish. They also prey on other predators like dogs, leopards, bears and crocodiles.

They do not usually prey on adult Asian Elephants and Indian Rhinoceroses but some cases are reported. More vulnerable small calves are hunted more often though. The tigers feed on domestic livestock when in close proximity to humans. Although they are carnivorous, tigers feed occasionally on vegetation like the fruit of the slow match tree for dietary fibre.

Tigers are mainly nocturnal predators who hunt in the night but there are few recordings from hidden cameras of them hunting in daylight in areas where humans are absent. They usually hunt alone and ambush their prey like the majority of the cats.

They overpower the prey from an angle, using their body's size and strength to jolt the prey off its balance. It then grabs the throat or nape with its teeth of the prey to successfully hunt and kill the prey.

The tigers can reach speeds of about 49 km/h to 65 km/h despite their large size. However, this is possible only in short bursts. Hence, they have to be close to the prey before they break their cover.
If the prey senses the tiger's presence before this and tries to escape, the tiger usually abandons the hunt instead of chasing the prey or battling it face to face.

When hunting larger animals tigers prefer to bite the throat and use their forelimbs to hold on to the prey, simultaneously wrestling the prey to the ground and strangling it to death. By this method, enormous water buffaloes and gaur with a weight of over a ton have been killed by tigers who only weigh one-sixth of the prey.

After killing their prey, the tigers drag it to a concealed place with vegetative cover by pulling it by grasping with their mouths and feed at their own leisurely pace. An adult tiger has the capacity to live without eating for up to two weeks and then feast on 34 kg of flesh at a single time.

Even though tigers are solitary, avoid each other and usually prefer to eat the prey they have caught by themselves, they sometimes share their kill with other individuals, even to those who are not related to them.

Tiger as an Endangered Species:

Tigers have faced several threats over the years and still face many. Poaching and large scale loss of habitat and prey are by far the greatest threats to them. They are followed by climate change.

Tiger hunting took place on a large scale during the early 19th and 20th centuries. It was recognised and admired as a sport by the British in Colonial India as well as by the Maharajas and Aristocratic class of the princely states of pre-independent India. A single Maharaja or English hunter claimed to kill a minimum of hundred tigers in their hunting career.

The tiger has historically been one of the big five game animals of Asia and was hunted for prestige. In some places such as China, those who managed to kill them were hailed as heroes to the general public as tigers were perceived to be a threat to human life in the area.

The tigers were also killed for their body parts and skin. Tigers were hunted in huge numbers so that their famous striped skin can be collected. The trade in tiger skin rose to a peak in the 1960s, just before the conservation efforts took effect.

At the same time, tigers were hunted for their body parts such as bones, skin and teeth to meet the growing demand for remedies made from tiger parts in Asia. It was discovered in 1986 that tigers were declining rapidly due to being poisoned, snared or shot and then smuggled out of India to supply medicinal manufacturers in China.

Since that time, hunting and trade of tiger parts has been banned. However, the introduction of this ban did not stop hunting. Illegal poaching of tigers continued and tigers were also farmed legally for their body parts privately.

Even though international trade of tiger parts was banned, domestic trade and illegal trafficking still continued. Illegal demand for tiger bones (used in tonics and medicines), tiger skin (seen as a status symbol) and other body parts, drived the killing and trafficking.

One of the saddest facts is, along with illegal poaching loss of habitat due to human encroachment and habitat degradation for agriculture. The climate change due to increased pollution led to ocean level rise and reduction in coastal areas like India's Sunderbans.

The tigers lost more than 93% of their historical and natural range due to land development and increase in pollution and this large-scale destruction and fragmentation of the habitats forced the tigers to move towards the area where people lived. This in turn made illegal poaching easier.

The continued demand for tiger parts in the Black Market, loss of habitat and increase in the number of captive tigers started pushing the species toward extinction. The population of tigers decreased from about 1,00,000 to about only 5,000 to 7,500 during the 20th century.

Three subspecies of the tigers namely the Caspian tigers of central Asia, the Javan tigers and the Bali tigers became extinct during this time and the other six subspecies drastically decreased in number. The number of tigers in captivity increased more than those in the wild.

The International Union for the Conservation of Nature (IUCN) then categorised the Amur/Siberian, Indochinese and Bengal tigers as endangered species and the Sumatran, Malayan and South Chinese Tigers as critically endangered species.

Conservation of Tigers:

Serious concern was expressed during the latter half of the 20th century for the declining number of tigers, and gradually all countries in the tiger's range started taking measures to protect the species, but with varying degrees of success. The tigers became legally protected but the law enforcement was not effective universally.

When poaching still continued even after hunting was banned, a new approach to conserve tigers was developed. Tiger Conservation Units (TCUs) in 15 habitat types within five bioregions were developed.

The TCUs were blocks of habitat that were capable of hosting tigers and a total of 143 TCUs were identified, prioritized based on size and integrity of habitat, pressure from poaching and population status and protected.

The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) played a crucial role in improving international efforts for tiger conservation. One measure aimed specifically at protecting the tiger was visible in the network's efforts to ban the trade of tiger derivatives or tigers.

CITES made the member states agree to adhere to this international trade ban and ban such trade within its national borders also, once member states ratify and implement CITES. The CITES Secretariat which is administered by the UNEP worked closely with several NGOs such as The Trade Records Analysis of Flora and Fauna in Commerce (TRAFFIC) to help the member states implement the convention.

They provided the states with training and information about requirements whenever necessary along with monitoring and evaluating the progress made by the member states. The Tiger Range Countries (TRC) where the tigers still roamed about freely in the wild were all a part of this convention.

The countries included:

- Bangladesh
- Bhutan
- Cambodia
- China
- India
- Indonesia
- Laos
- Malaysia
- Myanmar
- Nepal
- Russia
- Thailand
- Vietnam
- North Korea

North Korea is the only country listed in CITES which has not yet ratified CITES. The CITES is working to conserve tigers even now and recently in a conference held in Russia all the 13 TRCs have jointly vowed to double the current tiger population left in the wild.

India, which accounts for the majority of the Earth's tiger population, declared its conservation project called Project Tiger in 1973. It was started by Indira Gandhi, the then prime minister, as a major effort to conserve tigers and their habitats in India.

Project Tiger was aimed to conserve tigers in specially-constituted tiger reserves. It strived to maintain viable tiger populations in their natural environment. Several tiger reserves were

established under it and as of 2019, 50 reserves covering an area of 37,761 km2 dedicated to tiger conservation have been established.

Project Tiger proves to be a very successful program. The project was credited for tripling the number of Bengal tigers in the wild from some 1,200 in 1973 to over 3,500 in the 1990s but a 2007 census showed that population had reduced back to about 1,400 tigers due to poaching.

However, a 2014 census estimated a population of 2,226, a 30% increase since 2011. In addition to that, the 'Tiger Estimation Report 2018' released by the Indian Prime Minister Narendra Modi on the International Tiger Day of 2019 estimated a population of 2967 tigers in India with a 25% increase since 2014. With this increase, India became one of the safest habitats for tigers.

Following India, countries including Nepal, Malaysia and Indonesia also have set up strings of National Parks and Wildlife Sanctuaries that protect tigers. Thailand, Cambodia and Vietnam are now pursuing the same course with the intention of saving the leftover population of tigers.

In China, though tiger hunting was prohibited in 1977 after tigers had become the target of large-scale 'anti-pest' campaigns in the early 1950s, the population of tigers continued to decline. China earlier rejected being a part of Western-led environmentalist movements. However, it changed its stance in the 1980s and became a part of the CITES treaty.

By 1993, China managed to ban trade in tiger parts and diminish the use of tiger bones in traditional medicine. China's efforts to save tigers have continued and China has been giving special attention to conservation of tigers since then.

However, Tibetian people continued to trade tiger skins and made clothing and chubas made from tiger skins. In 2006, the 14th Dalai Lama was persuaded to take up this issue by the conservation organisations.

After the Dalai Lama started publishing information and spreading knowledge on ecological and environmental issues, there was a change in attitude of the Tibetians. They have started

their own conservation programs and some Tibetians have even started burning their chubas publicly to spread awareness.

In Russia, where poaching seriously endangered the Siberian tiger, anti-poaching controls, networks of protected zones, concentrated effort and effective patrolling have resulted in a revival of the subspecies.

Apart from conservation efforts from the governments of the respective countries, several NGOs like Panthera Corporation, World Wide Fund for Nature, National Geographic Society and Wildlife Conservation Society and multitudes of individual activists have worked together and are still working around the world to conserve our tigers.

There is still time for us to save our tigers. If we all come together and make small contributions to protect tigers, our future generations for sure will be able to see the majestic creature walking in a forest and not as a skeleton next to in a museum!

Extinction: The Great Auk and The Po'ouli

Extinction:

A species is the basic unit of ecology. It consists of closely related organisms that are capable of interbreeding and producing offspring. The diversity of species on Earth is incredible. Currently, the estimated number of species on Earth ranges from 2 million to 1012, of which only about 1.74 million have been identified and recorded till now.

Each and every species, however small, plays an important role in the ecosystem. They are fundamentally important for a well-balanced ecosystem. The species richness or the number of species in a given area enhances the ecosystem's productivity and stability.

When one species or group of taxa come to an end ie. all the individual organisms of a species die, it is known as extinction. Extinction is a natural process that is a part of evolution. However, nowadays, nature is declining at unprecedented rates and the rates of extinction are rising rapidly.

Extinction of any species is an irreversible loss. It is a diminution to the Earth's biological richness and diversity. If we lived in an ordinary time, then seeing a species vanish would nearly be impossible. However, we do not live in an ordinary time and everywhere we see, species are winking out.

Species extinction is taking place a hundred times - or even a thousand times - faster than usual mainly due to shrinking habitat. Habitat loss as we develop land for infrastructure, agriculture, etc. is the largest threat to all flora and fauna. Even when a habitat is not lost entirely, the changes made in it causes difficulty in survival for its inhabitants.

Hunting, poaching, fishing, overharvesting, pollution, introduction of invasive species, climate change and spread of diseases due to trade also causes extinction. All of these threats lead back to humans and their increase in dominance, either directly or indirectly.

The Great Auk:

The Great Auk also known as the garefowl or gairfowl is a species of flightless alcid that has been extinct from the mid-19th century. It is not closely related to the penguins as they were discovered long after the great auk and was named so due to their physical resemblance to great auks by the sailors. Great auks belonged to the family alcidae and its scientific name is Pinguinus impennis.

The great auk was one of the 4,400 animal species that was described formally by Carl Linnaeus in Systema Naturae, his 18th century work. However, the great auk was described as Mergus Americanus by Charles d'Ecluse in literature even before this. A woodcut which represents the oldest unambiguous visual depictions of the bird was also included along with the description.

Until 1791, the great auk was not placed in its own scientific genus, Pinguinus. Its name 'Pinguinus' is derived from the Latin word 'pinguis' meaning 'plump' while impennis also originated from Latin and refers to the lack of flight feathers or pennae.

The adult great auks were about 75 to 85 centimetres tall and had a weight of approximately 5 kilograms. They were the second largest members of their family and order. The birds that lived in the north were larger in size than those from the south. Both males and females were identical but their plumages had minor differences.

The great auks' back was glossy black and their belly was white. They had short necks and legs and small heads and wings. They developed a wide white patch over each eye that had either a hazel or chestnut coloured iris during summer. The great auks' eye patch along with the old feathers were replaced with a wide white band and a gray line of new feathers that stretched from the eye to ear during the winter.

Their throats were blackish-brown and inside of the moth were yellow during the summer while their throats became white during the winter. The great auks had large bills that were curved downwards and had deep white grooves. Its feet and short claws were black and had webbed skin between the toes. Their legs were far back on their body.

The great auks were very specialized piscivores and usually ate fishes that were 12 to 20 cm long and had high fat content. The young ones may have eaten smaller fishes or even zooplankton. Being social birds, the great auks lived and foraged in small groups.

They might have performed some types of visual displays, like head shaking, bowing and presenting their bright yellow gapes. Their voices generally being louder and deeper than the razorbills, great auks made low croaks and hoarse screams. In addition to this, they used visual displays for communication.

Although flightless, the great auks were tremendous divers and very powerful swimmers. However, as their legs were placed so far back on their body they were clumsy when walking in an upright posture on land.The Great auks spent most of their lives in the sea and left the waters only for breeding and sometimes for roosting.

They mainly lived in the North Atlantic coastal waters along the coasts of Canada, northeastern United States, Norway, Iceland, Greenland, Scandinavia, the British Isles, France and northern Spain.

The great auks' nesting area required rocky islands with gentle, sloping shorelines that provided easy access to the sea. The nesting sites also had to be close to rich feeding areas but far enough from the mainland to be out of sight to the predators.

These requirements were very limiting and it is believed that the great auks had no more than 20 breeding colonies. Only seven former breeding sites of the great auks are known and they include St. Kilda, Geirfugl Asker near Iceland, Papa Westray, Grimsey Island, Eldey Island, Bird rocks in the Gulf of St.Lawrence and Funk Island off Newfoundland. Their breeding season was from May to June or August.

The great auks migrated north and south away from the breeding sites after the chicks fledged. These birds used to leave the breeding islands in late August or September, and returned back in early spring. They also tended to go southwards in late autumn and winter. However, even in the winter, they did not go any further south than Massachusetts Bay.

Extinction of the Great Auk:

The great auks were utterly defenseless birds. It was considered that the Little Ice Age may have reduced the population of the great auks by exposing their breeding areas to predators along with reduction in population due to exploitation by humans. However, recent evidence has proved that overexploitation by humans was the primary and maybe also the only reason for the reduction in its population.

There was great demand for the eggs, feathers, fat, oil and meat of the great auks. By the mid-16th century, all the nesting colonies along the European side were nearly destroyed from killing the birds for its down, which was then used for making pillows.

In 1553, the great auks were first given official protection. In 1794, Great Britain banned killing the great auks for their feathers. In 1175, St.John banned hunting them for their eggs or feathers. However, hunting for using their meat as bait for fishing still continued.

Meanwhile, on the North American side, when eiders nearly became extinct, down collectors switched to the great auk. Enormous numbers were captured, the birds often being driven up a plank and killed on their way into the hold of a vessel.

They were also slaughtered in other gruesome and cruel ways. In Newfoundland and Funk Island, the hunters corralled them into stone enclosures. If the hunters came only for their feathers, the hunters did not take trouble by kindling them. They just plucked the best feathers off and let the birds die slowly at leisure with their skin half naked and torn off.

The hunters used to carry a kettle where they put some birds and lit a fire under the kettle by burning a bird or two. If not skinned alive by the hunters, they were burned alive instead of wood to heat water that was used to scald feathers off and cook more birds. The great auks soon disappeared from Funk Island by the 1800s.

With increasing rarity, the great auks and their eggs became collectibles and highly prized by the rich Europeans. The demise of the species was also due to the loss of a tremendous number of eggs to the collections. Also, the eggers only collected the eggs without the embryos and discarded those with embryos growing inside.

In 1840, in the month of June, three sailors from St.Kilda landed on an islet which was known as Stac-an-Armin. When they were climbing out, they noticed a peculiar bird - Great Auk - that was just under three feet tall, wings, black and white plumage and a hooked beak waddle clumsily on land.

Perhaps thrilled by the idea of hunting or perhaps due to the realization of the bird's incredible value, the men tied the bird up and abducted it back to their ship. They kept it alive for three days and it continuously squawked and tried to bite through the rope tied around its leg.

But on the fourth day, a terrible thunderstorm blew in and the sailors became fearful and superstitious. Believing that the bird was a maelstrom-conjuring witch, the three men stoned the bird to death. It was the last of its kind to ever be seen in the British isles and sadly was killed in such a barbaric way.

The last colony of great auks lived on Geirfuglasker. This islet was surrounded by cliffs and was not accessible to humans, but after it was submerged after a volcanic eruption, the birds moved to a nearby island of Eldey. This island was accessible from one side and when that colony was first discovered, there were nearly fifty birds present.

However, museum trade finished it off. The museums, wanting to collect their skin and eggs for preservation and display, quickly began collecting the birds from that colony. The last pair of the great auks was incubating an egg when they were spotted by two men.

As the birds fled for their safety, the birds were attacked, captured and killed by the men on a request from a merchant who wanted the specimens. The egg that the female was incubating was crushed by a fisherman with his boot as he raced with the other man to catch the adult birds. The men didn't know it, but they had just killed the last great auks ever seen alive and as he crushed the egg, he stamped out the species for good from Earth.

In conservation biology, there's a rule: that if a species is below 500 individuals, it's doomed to extinction. However, there were millions of great auks and still they went extinct! Now 78 skins along with approximately 75 eggs and 24 complete skeletons remain, mostly in museums.

Po’ouli:

The po‘ouli, also known as black-faced honeycreeper, is an extinct species of passerine bird. They were endemic to the island of Maui in Hawaii and were one of the world’s rarest species of birds. It is considered to be a member of the subfamily Drepanidinae or the Hawaiian honeycreepers. It is also the only member of the genus Melamprosops.

The scientific name for po’ouli is Melamprosops phaeosoma. The po’ouli lived only on the drier and easternmost side of Maui. With the threats of extinction, they were also bred in captivity. They used to nest in native ōhi‘a lehua forests and seldom called or sang. The po'ouli spent most of their time on the ground and in low vegetation hunting as they mainly fed on native tree snails and other insects and spiders.

The po’ouli were greyish-white below and brown above with a broad black mask that extends till behind the eye. Adults were silvery-gray above the mask, shading into brown at the crown and a bold, pale patch behind the mask. While, the younger ones were similar too but with a smaller mask, a bit buffier below and without grey above.

The po’ouli was discovered in 1973 by the students from the University of Hawaii. They were found on the north-eastern slopes of the Haleakala on the island of Maui at an altitude of 1,980 metres above sea level. They were found during the Hana Rainforest project.

Po’ouli was a new species that was unknown to even the Hawaiian oral tradition. The new species was eventually given the name Po’ouli which means “black-faced” in Hawaiian. It was the first species of the Hawaiian honeycreeper that was discovered ever since 1923.

Evidence based on DNA suggests that it belongs to an ancient lineage of Hawaiian honeycreepers. However, it was not similar to the other Hawaiian birds both lying or fossilized. Therefore, it is believed that the po’ouli had outlived all of its close relatives if at all it had any.

Extinction of the Po’ouli:

Until a decade after the discovery of Po’ouli, not much was found about them. A survey done later in 1980 on the birds on the Hawaiian Islands estimated the population of the po’ouli between 100 and 200.

Later continuous observations suggested that there was a decline in the population of the po'ouli by over 90 percent within a decade after its discovery. In the late 1980s, the po'ouli disappeared from the easternmost part of its range and was found only in the western branch of the Hanawi Stream.

It was then identified that this was caused due to increasing habitat damage caused by the feral pigs. These feral pigs had been causing havoc in Hawaiian islands over a long period of time and they particularly damaged native plants and birds.

The pigs used to rototill soil in search of morsels, dismember tree roots, and rip out ferns and other understory plants which were both home and sustenance to native insects and snails that made up the most of the po'ouli's diet. The pigs also directly munched on the native plants, snails and sometimes even the eggs of birds, contaminated streams with their droppings, trampled the forest floor, tore up creek beds and excavated wallows.

The pig wallows became breeding grounds for mosquitoes that carry avian malaria and bird pox. The Hawaiian native birds were not immune to mosquito-borne diseases and such diseases caused the death of several endemic birds and the po'ouli was one of them.

To preserve the po'ouli and all the other endangered flora and fauna of that region, the State of Hawaii established the Hanawi Natural Area Reserve. This connected several protected areas into one larger protected area.

Containing the highest densities of native birds on Maui, the Hanawi Reserve was fenced off to exclude feral pigs and allow the understory to regenerate. In 1996, they then began to clear out the pigs from the closed areas. The po'o-uli pen was completely cleared of pigs after Four years and 202 pigs.

However, in 1994, a "rare bird search" was initiated to find all of the critically endangered forest birds in Hawai'i and those searches detected fewer than ten Po'ouli remaining in Hanawi. By 1997, only three Po'ouli individuals could be found and were known to exist and

they were located in three geographically separate home ranges in the Hanawi Natural Area Reserve.

The three known Po'ouli were all captured and banded in 1997 and 1998 verifying three different individuals in three different areas. No more Po'ouli were found despite many hours in the field searching . In 1998, experts all over the globe were consulted to implement a recovery plan.

When the three individuals were captured for branding their feather samples were also taken for DNA analysis. Several labs were consulted for sexing, however conflicting results were returned as there was no known DNA library to reference for this species.

Only one lab was confident and stated that the remaining Po'ouli were two females and one male, building hope for the recovery of the species. The first step in order to save the Po'ouli was getting the birds to produce young was to bring the birds together so that they can reproduce.

In 2002, one of the individuals, a female, was captured and taken to the male's home range in an attempt to get them to breed. However, the next, the female slowly made her way across the mountain and back to her own home range.

In 2002, it was also decided that it was time to bring the three remaining birds into captivity at the captive-breeding facility in Olinda, Maui run by San Diego Zoo Global. Following this decision, a ten-day expedition was carried out with the goal of capturing the three birds.

On September 9, 2004, one of the remaining individuals, a male, was captured and taken to the Maui Bird Conservation Center. The male was a very old individual with only one eye and despite all attempts to help the bird, he died on November 26, 2004 before the biologists could find a mate.

The other two individuals, who were believed to be the only remaining Po'ouli in the world, were also last seen during this same period and were never seen again. Even extensive surveys failed to locate these or other individuals of this species.

It remained listed as critically endangered by BirdLife International and thereby the IUCN, for a long time, until additional surveys had confirmed the Po'ouli's extinction beyond reasonable doubt.

The dramatic decline in population has been attributed to a number of factors, including mosquito-borne diseases, habitat loss, a decline in the native tree snails which was a major part of the po'ouli's diet and predation by pigs, rats, cats, and small Asian mongooses.

After continued habitat degradation, presence of diseases and invasive species, and a long period with no sightings, the IUCN classified this bird as Extinct, in 2019.

And with that the po'ouli's quiet struggle for survival came to an end. However, there is no time for silence about the struggles that yet endure and live on.

P.S.: However, tissue samples were taken from the male captured in 2004 for possible future cloning and we might as well keep our eyes and ears open as I tend to be one of the optimists who feel we may still see another even after the declaration of its extinction.

Halting the Extinction Crisis:

Famed conservation scientist E.O. Wilson quoted that "If you save the living environment, the biodiversity that we have left, you will also automatically save the physical environment too. If you only save the physical environment, you will ultimately lose both."

Our Earth ecologically has a tightly wound balance. Each time a species goes extinct, this balance unravels a little. The consequences are profound not only in just the places where the extinction takes place but around the world. There are numerous tangible negative consequences for every species extinction.

Although we lead a fast, modern life away from nature, we are still deeply connected to nature and its irreplaceable beauty. Nature has inspired us since ancient times and has brought us joy and enrichment. Every extinction makes this globe a bit more lonelier for both us and our future generations.

In less than 10,000 years, humans have become the most dominant species on Earth and this has come with a steep price for the wildlife. Our planet is now witnessing an extinction crisis that has never been faced by humankind and it is due to our own activities.

Countless species have already become extinct and it is predicted that over a million more are on the verge of extinction. Some losses will remain forever but it is not too late for many. Time still left out to make a difference.

Humans have exploited the wildlife over years. However, now, every year, more and more conservation centres are being established. Both marine and terrestrial protected areas are being instituted around the world to conserve wildlife and their habitats.

Many international biodiversity conservation conventions are brought into order to conserve and restore ecosystems. Many programmes for tackling invasive species and spread of diseases are set up.

Both fragmented and completely destroyed habitats are being restored. Dams are being removed so that the rivers are restored to their original state and aquatic ecosystems can thrive.

Several people have started volunteering to protect the wildlife in their areas by running their household in an eco-friendly way, planting native flora, using organic goods, recycling, buying recycled or reusable products, reducing pollution caused by them and raising their voice and working along with conservation organizations.

Several other intense conservation practices are being employed thus far to stop the annihilation of Earth's natural heritage. With more care, love, knowledge and restraint we can promise a place for each and every species on Earth, in all their spectacular forms and extraordinary varieties, even now.

Jim Corbett National Park: The Land of Roars, Trumpets and Songs

National Parks:

National parks are parks created and protected by the national governments for conservation purposes. They are mostly protected areas or reserves of natural, semi-natural or developed land that the nation owns or declares.

National parks are defined as Category II type of protected areas by the International Union for Conservation of Nature (IUCN) and its World Commission on Protected Areas (WCPA). According to IUCN, there are more than 6,555 national parks worldwide that meet its criteria. However, IUCN is still discussing the parameters of a national park.

National parks are usually always open to tourists and visitors and tourism in national parks have increased with time. National parks now have become a high quality natural environment with a well-designed tourist infrastructure and a center for nature-based tourism.

The United States established the first national park in the world, Yellowstone National Park, in 1872. However, Tobago Main Ridge Forest Reserve and the area surrounding the Bogd Khan Uul Mountain are seen as the oldest legally protected areas.

As of now, the largest national park in the world according to the IUCN is Northeast Greenland National Park while the smallest official national park in the world is the Iles de la Madeleines National Park.

However, India's first national park was established in 1936 as Hailey National Park and is now known as Jim Corbett National Park. It is located in Nainital district and Pauri Garhwal district of Uttarakhand. Jim Corbett National Park is a part of the larger Corbett Tiger Reserve, a Project Tiger Reserve.

Its magical landscape is well known and fabled for its tiger richness. Jim Corbett National Park not only has the glory of being India's oldest and most prestigious National Park but also is honored as the place where Project Tiger was launched first.

This unique tiger territory is best known as the father who gave birth to the Project Tiger in India. This National park is also known as the land of the roars, trumpets and songs due to the presence of high magnitudes of the Royal Bengal Tigers, Asian Elephants and bird species.

India had only 5 national parks in 1970. Nonetheless, after the Wildlife Protection Act and Project Tiger were enacted and federal legislation was strengthened, the number of national parks has increased. And as of May 2020, there are 101 national parks under the category II of protected areas of India.

History of Jim Corbett National Park:

Being the oldest national park in India, Jim Corbett National Park has a gripping and vast history. Some areas of the National Park originally belonged to the princely state and the kings of Tehri Garhwal. It was their private property until it was cleared and converted.

Tehri Garhwal was captured by the Gorkhas and was ruled for about 12 years by them. In return for their help in driving out the Gorkhas, the then king of Tehri formally transferred a part of the princely state to the British.

A tribe from the Terai called the Buksas settled on this land and started practicing agriculture but were evicted by the British. The British then embarked on preserving the forest. The first initiative to conserve the forests took place under Major Ramsay, a British officer, by protecting the area by prohibiting crop cultivation and cattle farming in 1868.

Later, in 1879 the forests were declared as a Reserve Forest and only very minimal and limited felling was allowed. In the early 1900s, an idea to set up a national park on the territory was proposed by the British like E.R. Stevans and E.A. Smythies. Therefore, in 1907, the British administration considered the proposal and took the initiative to establish a game reserve.

However, it was only in the year 1930 that the process of setting the boundary started. It was carried out under the supervision and leadership of Sir Edward Jim Corbett. Finally, in 1936, a reserve area known as the Hailey National Park covering an area of 323.75 sq. km was established.

The Hailey National Park was India's and Asia's first National Park and it was named so because the national park was established under Sir Macolm Hailey, the governor of the province.

After the independence, in 1954-1955, the national park was renamed as the Ramganga National Park. However, in 1955-1956, it was again renamed as the Jim Corbett National Park as a tribute to Sir Edward Jim Corbett for his help in the establishment of the national park.

Hunting was prohibited in the reserve and cutting timber for domestic purposes was allowed. Soon after that, rules that prohibited killing and capturing of mammals, reptiles and birds within the reserve were also passed.

The national park prospered in the 1930s. However, it faced excessive poaching and timber cutting during the Second World War. In 1974, this rich, wild ecosphere was selected as the launch pad of Project Tiger, an ambitious wildlife conservation project of the Indian Government.

Later in the 20th century, around 1991, the national park was added to the Corbett Tiger Reserve. During this addition, the entire Kalagarh forest division that also includes a part of Sonanadi Wildlife Sanctuary of area 797.72 was added to the tiger reserve.

Currently, the area of the Jim Corbett National Park is 521 sq. km. The bigger Corbett Tiger Reserve consisting around 521 sq. km of the core area and around 797.72 sq.km of buffer zone has a whopping area of 1,318.54 sq. km.

The Jim Corbett National Park is also one of the thirteen protected areas that is covered by the World Wide Fund under their Terai Arc Landscape Programme. By restoring the corridors of forest that link the 13 protected areas and by enabling wildlife migration, this program protects

three out of the five terrestrial flagship species namely, the tiger, the Asian elephant and the Indian one-horned rhinoceros.

Geography and Climate of Jim Corbett National Park:

The Jim Corbett National Park is located at the foothills of the Himalayas, in Uttarakhand along the banks of Ramganga. The altitude of this region ranges from 360m to 1,040 above sea level.

The national park has numerous ridges, ravines, minor streams and small plateaus with a variety of aspects and different degrees of slope. Its whole area comprises hills, marshy depressions, riverine belts, grasslands and even a large reservoir or lake.

The national park occupies mainly the Patli Dun valley formed by the Ramganga River and this river is dammed at the western end of the park to form the large reservoir in the reserve's center. The national park protects the parts of the Himalayan subtropical pine forests and the moist deciduous forests of the Upper Gangetic Plains.

The Corbett tiger reserve with the national park as its core area has a sub-Himalayan belt structure as it is located partly along a valley between the Lesser Himalayas and the Shivaliks. The sandstone units form broad ridges and the upper tertiary rocks are exposed towards the Shivaliks' base. The formation of characteristic longitudinal valleys called Duns or Doons can also be seen along the narrow tectonic zones.

When compared to other protected areas in India, the Jim Corbett National Park has a moderate temperature. It has a humid subtropical and highland climate that ranges from 5°C to 30°C during the winter and rises up to the maximum of 40°C during the summer. The winter mornings here are usually foggy and the national park receives heavy rainfall during the monsoon.

Jim Corbett National Park's Flora:

The vast ecosphere of the Jim Corbett National Park displays a plethora of varied species of plants. It is an ideal place to familiarize with several divergent species of plants. The national

park has 600 species of plants including species of grass, ferns, herbs, shrubs, climbers, bamboos and trees.

75% of the total area of the national park is covered with Sal, Khair and Sissoo trees. Chir pine is the only conifer of the park and is found on the ridge-tops like Chir Choti and the upper regions near Kanda have Banj Oak, a Himalayan species, growing.

Palms growing in the national park include Khajur or the Date Palms and *Wallichia densiflora*. *Wallichia densiflora* is a rare palm species of the Eastern Himalayas. However, this is found near Sultan in Corbett National Park.

Kanju, Jamun and Amla are also found scattered throughout the lower areas of the national park Tendu is found in the moist areas of Corbett. Other major tree species include Kusum, Bakli, Bel and Mahua. The Corbett National Park is also popular for several species of flowering plants which add color to the forests.

The main flowering plants present in the forests of Corbett National Park are Kachnaar with pink to white flowers, Dhak or Flame of the Forest with bright orange blooms, Semal with big red flowers, Madaar or Indian Coral with scarlet red blooms and Amaltas with bright yellow flowers that resemble a chandelier.

Some species of trees have also been planted artificially in and around the national park and these trees include Teak, Eucalyptus, Jacaranda, Silver Oak and Bottlebrush. These trees can be found near the rest houses present in the national park.

The tree understory and the scrub areas of the forests are dominated by shrubs. Several species of Ber are found in the open areas and these shrubs provide food and shelter to birds and animals. *Maror phali* is a shrub that is found easily in these forests and they have fruit in the form of twisted spiralling pods.

Hisar with juicy, yellow, mulberry-like fruits are also found in these forests. Karaunda, Jhau, *Colebrookea oppositifolia* and Adhatoda are other shrubs present in the national park. Karaunda with sour fruits and pinkish white flowers are seen under sal trees, Jhau is found along the

Ramganga basin on sandy soil and *Colebrookea oppositifolia* and *Adhatoda vasica* can be noticed in Nallahs.

The Corbett National Park's vegetation also has an abundance of bamboo. The main species present in these forests is Male Bamboo and they have clustered short stems and shiny and papery steam sheaths. All the bamboos in the forest flower once in several decades and altogether at the same time. All the bamboo individuals also die together, after the flowering, fruiting and seed dispersal.

Herbs present in the Corbett National Park include many species of wildflowers that mostly belong to the Pea and Aster families. *Drymaria diandra*, an annual herb with heart shaped leaves and Bhilmora, a sour tasting herb used to make chutney, are the major species of herbs found here.

Euphorbia hirta, a hairy herb, Clover, a herb with three leaflets, *Indigofera linifolia*, a herb with bright red blooms and *Solanum sp*. and *Leonotis nepetifolia*, herbs with orange flowers and spiky round fruits are other species of herbs that can be noticed in Jim Corbett.

Jim Corbett National also has over 70 species of grasses that occupy different habitats. Kansi, *Themeda arundinacea*, Baib or Bhabar, Narkul, Tiger Grass, Khus Khus, *Cymbopogon flexuosus*, *Aristida cyanantha*, *Neyraudia arundinacea* and *Heteropogon contortus* are some species of grass that can be encountered in high numbers in Jim Corbett.

Some woody climbers like *Millettia auriculata*, *Cryptolepis buchanani*, *Porana paniculata*, *Clematis gouriana* and *Bauhinia vahlii* are found in the national park. Epiphytes that grow above the ground on other plants are also found on sal and other trees in the national park.

Some Epiphytes that can be encountered here include *Dendrophthoe falcata*, *Scurrula cordifolia*, *Vanda testacea* and *Cuscuta reflexa* or Dodder. There are some semi-aquatic species of plants that occupy the marshy area of the Corbett national park and they include *Polygonum*, *Veronica*, *Hypericum*, *Ranunculus* and more.

Apart from all these varieties of plant species, there are also some non-flowering plants. They include ferns, mosses and lichens. Ferns occur in cool, shady, moist areas along the streams and *Adiantum*, *Pteris*, *Ophioglossum reticulatum* and *Equisetum* are some species of ferns found in the national park.

The presence of lichens provides good air and environment. Many types of colourful lichens grow on mature tree trunks and boulders all over Corbett and the mosses are found on moist tree trunks.

Jim Corbett National Park's Fauna:

The Corbett National Park is home to several endangered species of animals. The national park was established to shelter and protect the Royal Bengal Tigers. Corbett has one of the highest densities of the tigers, the most celebrated wild animals of India.

Tigers have always had a very closely knit relationship with the Corbett National Park. First, through the writing of Sir Jim Corbett and later due to Project Tiger, India's first Tiger conservation programme that was initiated from the soil of this very park.

Bengal tigers, although plentiful, are not easily spotted due to the abundance of foliage or camouflage in the reserve. A high number of leopards are also found in Jim Corbett National Park in the hilly areas but may also venture into the lowland jungles. These leopards are far more easily spotted than the tigers.

The elephant, largest of the land mammals, has always been an integral part of the history, mythology, tradition, culture and religion of India. There are only three surviving species of elephants in the entire world, one in Asia and two in Africa and the Asian elephant is widely distributed all over the Indian subcontinent. Corbett Tiger Reserve has over 700 Asian elephants and in the summer, they can be seen in herds of several hundred.

Jim Corbett National Park is a refuge to 4 different species of deer. They are the most frequently sighted mammals in the entire park. Chital or spotted deer is the most common deer of Jim Corbett. It has a reddish-brown body with white spots and is claimed to be the most beautiful of all species of deer.

Hog deer is the rarest species of deer in Jim Corbet and is closely related to the Chital but a bit smaller in size with short limbs. Unlike other deer species, hog deer crouches low and ducks under obstacles instead of leaping over the obstacles to escape from their predators.

Sambar is Corbett's largest deer species and its body is uniformly greyish-brown in color except for the creamy white on the back and under-tail regions. The fourth and final species of deer present in Jim Corbett is the barking deer. They are dark brown to yellowish and grayish browns and have a darker head. They make a bark-like sound as an alarm when in danger.

We can spot several species of small cats like the jungle cat, fishing cat and leopard cat in the national park. Sloths, yellow-throated martens, Hiamlayan Goral, Himalayan black bears, Indian grey mongoose, Indian pangolins, langur and Rhesus macaques are other mammals that are encountered in Jim Corbett.

Jim Corbett also houses several rare species such as Otters and the Endemic Fish-eating Crocodile. Corbett has two of India's three crocodilian species namely the Gharial and Mugger. It is considered to be one of the best spots to see the Gharials and they are one of the largest and most endangered crocodiles of the world found only in the Indian subcontinent.

One of the other major attractions in Jim Corbet is the Indian Rock Python. King Cobra, Indian Cobra and several kinds of vipers, kraits and boas are also found here. Apart from these, Jim Corbett is a haven to over 586 species of resident and migratory birds, 33 species of reptiles, 7 species of amphibians, 7 species of fish and 36 species of dragonflies.

Jim Corbett is famous for its rich birdlife whose multiplex behaviour and varied songs are intriguing and very pleasing to the ear. There are more than over 50 species of raptors alone in Jim Corbett National Park and this provides a unique character to the avifauna.

Great Pied or hornbill, Orange Breasted Green Pigeon, Hodgson's, Bushcat, Indian White-backed Vulture, Levant sparrowhawks, Black Partridges, Red Jungle Fowl, Black Crowned Night Herons, Crested Serpent Eagle, Blossom-headed Parakeet, Golden Oriole,

Pallas Fish Eagle, Indian Pitta, Tawny Fish Owl and Scarlet Minivet some resident bird species of Jim Corbett.

However, this richness in birdlife increases even further during the winter due to the arrival of several migrants from places like East Africa, Europe, Central Asia and even some places from the Himalayas. Some migratory birds include ospreys, some species of ducks, and Himalayan birds like flycatchers, great barbets and wallcreepers.

In the waters of the Ramganga, Palain, Sonanadi and Mandal rivers, several species of freshwater fish including Mahseer can be found. They form a fundamental link in the food chain for keystone species present in the national park including the gharial, otters, fish-eagles, kingfishers, ospreys, fish-owls, storks, egrets, pelicans and darters.

Food Chains of Jim Corbett National Park:

The Jim Corbett National Park has a very rich biodiversity and a well-balanced ecosystem. This is due to the intricately designed food chains and food webs. With so many species of plants and animals in the ecosystem, it is almost impossible to determine all the food chains within the national park.

However, here are some examples out of the infinite number of food chains present in the Jim Corbett National Park:

1. Nectar (Flower) → Butterflies → Dragonflies → Flycatchers → Snakes → Eagles
2. Grass → Sambar Deer → Bengal Tigers → Vultures
3. Grass → Grasshopper → Birds → Snakes → Vultures
4. Algae → Mahseer → Tawny Fish Owls → Jungle Cats
5. Grass → Chitals → Leopards
6. Algae → Mosquito Larvae → Dragonfly Larvae→ Mahseer → Gharials
7. Sour fruits → Himalayan Black Bears → Royal Bengal Tigers
8. Grass → Baby Asian Elephant → Royal Bengal Tigers
9. Algae→ Ducks → Otters → Black bear
10. Grass → Gorals → Leopards
11. Nectar→ Honey bee (Larvae & Honey)→ Sloths

12. Nectar → Honey bee (Larvae) → Oriental Honey Buzzard → Leopard Cats
13. Sour fruit → Golden Oriole → Jungle Cat
14. Algae → Mahseer → Fishing Cat
15. Grass & Weeds → Ducks → Grass

Diligence of Jim Corbett National Park:

The Jim Corbett National Park has faced numerous challenges and obstacles over the years. When the dam at Kalagarh river was constructed, 80 square km of prime low lying riverine area was submerged. Though the reservoir that was formed due to this increased the aquatic fauna and provided a habitat for the winter migrants, it also led to the local extinction of the swamp deer and reduction of the hog deer population.

Two villages situated on the southern boundary of the national park had to be shifted during the 1990s to design the regions as buffer zones. The families in these villages were entirely dependent on the forest for their living but the government had to relocate them for ecological restoration of that area.

Though it was a very difficult and drastic task, the officials took it upon themselves to accomplish the task. Now, the vacated agricultural grounds and areas of the village have several plant species growing and the newly arisen lush green field attracts grass eating animals like deer and elephants to migrate and stay there throughout the entire monsoon.

About 109 cases of poaching were recorded here in the years 1988 and 1989. However, in the years 1997 and 1998, poaching was reduced to about only 12 cases by intensive conservation methods.

In 1985, David Hunt, a British ornithologist and birdwatching tour guide was killed by a tiger in the national park but even this didn't stop the scientists and officials from continuing their responsibilities.

Even now, the habitat of the reserve is facing threats from invasive species such as the exotic weeds Lantana, Cassia and Parthenium. The trees and grasses are being exploited by the local

human population. The encroachment of a minimum of 13.6 hectares by 74 different families has been recorded.

Even though no new villages have come up in recent years, the rising population in already existing villages are posing a threat to the National Park. The close proximity of the villages to the reserve has caused the occurrence of a few incidents of killing of cattle by tigers and leopards.

This has led to acts of retaliation by the local population. However, even this issue has been tackled by the government by approving the construction of a stone masonry wall on the reserve's southern boundary where it comes to close contact with the agricultural fields of the villages. As of February 2014, nine local villagers have been killed by tigers from the Jim Corbett National Park.

However, even after facing so many challenges, deaths, and hardships, neither the government nor the park officials and scientists give up. They have continuously worked and are working even now to save the endangered species present in the National Park.

This perseverance and diligence of the officials and scientists should be respected and saluted at. As we clap hands for these authorities, let us also think about how we have contributed to conserve our Earth. The authorities of Jim Corbett National Park have already done their part to conserve nature and now it is our turn!

We sometimes underestimate the value and influence of small things. Every big thing is made of something smaller. Even the mighty ocean is made up of teeny tiny droplets of water. Whoever says small things doesn't matter, has not seen a match start a wildfire.

On Earth, there is no heaven, but there are pieces of it and we call it nature. Nature is the one miracle on which we all depend on ; nature is what we all have in common. Let us all work towards a better and brighter tomorrow! Let us unite and contribute small efforts to have a big impact! Let us be the match that starts the wildfire of conservation!

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