

# Evolution of Unmanned Aerial Vehicles in Nepal

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## KEYWORDS

*UAV Surveying, Drone Mapping, Flying Labs, Disaster Mapping*

## ABSTRACT

*Nepal has tremendous geographic diversity rising from as low as 59 metres elevation in the tropical Terai to the highest peak in the world, Mt. Everest, at 8,848 ft. The country ranks 4th, 11th and 30th as the most vulnerable country in terms of risk from climate change, earthquake and flood respectively.[1] As a part of response to any disaster, geographical knowledge of the vulnerable area is the foundation to effectively plan and implement the response. There exist various ways of topographical surveying and mapping which are being used to acquire such geoinformation. The undulating geography of Nepal makes topographical surveying and mapping time consuming and arduous through the traditional ground-based methodologies. Furthermore, the remote sensing techniques are not much useful for a country like Nepal that doesn't have its dedicated satellites and hence lacking ways to obtain timely updated information. The recent few years have seen escalation of some of the frontier technologies including Unmanned Aerial Vehicles (UAVs) in surveying and mapping, aerial photo/videography, surveillance and a number of other applications. UAVs were widely introduced in Nepal in the aftermath of the April 2015 earthquake. An unprecedented number of small and lightweight UAVs were flown over highly damaged areas and heritage sites by journalists and humanitarian responders to assist in immediate rescue, relief, and reconstruction efforts. However, risks to national security by the unregulated use of UAVs was realized by the Government of Nepal, and the Ministry of Home Affairs released a set of strict guidelines that controlled the use of UAVs in a stringent way. This limited use of UAVs in Nepal bottlenecked the increasing adoption of this technology, both for humanitarian responses and private sectors. However, increasing demand has recently led to the release of a comparatively flexible "UAV Flight Guidelines 2075" that provides the authority to grant UAV flight permissions for lightweight UAVs to the local governments, thus simplifying the procedure for most UAV users. It also reflects the positive change in perception of the government towards UAV technology. This study seeks to identify, analyze and document the evolution in application of UAV technology in Nepal across several application areas.*

## 1. INTRODUCTION

Nepal has a huge lag in terms of implementation of newer technologies, with a lot of technologies existing in their elementary phase until a few years ago. The recent few years have seen an escalation of some of the frontier technologies in Nepal, with a lot of involvement from a diverse sector in the development, sensitization and adoption of such technologies. One such dominant technology that has seen an exponential rise in its usage in Nepal is Unmanned Aerial Vehicle (UAV).

UAVs refer to uninhabited flying vehicles that operate based on the pre-entered program and/or on its own recognition of the surroundings (Jee & Kwak, 2014). They can be remotely controlled, semi-autonomous, autonomous, or a combination of these modes of operation. Various types of payloads, mainly cameras and other kinds of sensors, are integrated thereby making UAVs capable of capturing real-world data such as images, videos and geolocation, etc. (Van, 1999). UAVs can be used as tools/mediums of transporting goods, obtaining various kinds of data, and providing better situational awareness through images and videos, higher resolution and more real-time spatial data than satellites. Due to their portability, agility, ever-advancing technology and ever-increasing accessibility, UAVs are increasingly becoming popular and seeing newer use cases every now and then.

An unprecedented number of small and lightweight UAVs were flown in the aftermath of the Nepal Earthquake 2015 by journalists and humanitarian responders to assist in immediate rescue, relief, rehabilitation and reconstruction efforts. The hence seen proliferation of UAVs in Nepal in a very short span of time awakened and encouraged the policy makers to act promptly, to which they responded with enforcement of a flight operation directive. The directive required anyone wishing to legally fly drones within Nepal to obtain permission from multiple ministries and government authorities, and adhere to many restrictions including permissions to fly. The

then understanding of UAVs in the general public was of a technology of destruction and privacy obstruction. The perspective of the government authorities themselves on UAVs wasn't very welcoming either, given the lack of UAV experts and enthusiasts within the authorities. Over a short span of time, there was an increase in the use of UAVs by private businesses, researchers and tourists in various applications like topographical surveying & mapping, wildlife monitoring, aerial inspections, photography/videography, etc. The increase in the popularity of UAVs owing to its sensitization among people and authorities, and ever increasing activities relating to the use of the technology has led in better acceptance of drones in the public as well as the government authorities, and has led to a change in perspective about drones, and the drone regulations have also softened over time allowing more applications of drones (MoHA, 2019).

## 2. USAGE OF UAVS IN NEPAL

The development of UAVs in Nepal can be particularly divided into three stages: prior, during and post Nepal Earthquake 2015.

### 2.1 Usage of UAVs prior to April 2015

Few hobbyists from Nepal were involved in usage of UAVs prior 2015 with few of the documented ones dating back to 2008/2009. Many engineering colleges, through their robotics clubs, were developing UAVs, mostly for robotics competitions and college projects. Few private institutions had already been working in research and development of UAVs and related technologies from 2013. There were rare cases of documented UAV flights limited to confined purposes of documentary shooting, video filming or some research activities. Below are some significant works done in the field prior to the Nepal Earthquake 2015:

#### 2.1.1. Use of UAVs in anti-poaching efforts - WWF Nepal (2012):

UAVs were used as a conservation technology/tool for the first time in Nepal to monitor the

animals and poachers via camera and GPS (www.phys.org). WWF provided two UAVs to the Nepal Army in order to combat poaching and logging. A pilot test of the UAVs was conducted in June 2012 and, following the government's interest in this technology, WWF organized training for the same in September 2012 (WWF, 2012).

### ***2.1.2. Use of UAVs in glacier studies - ICIMOD Nepal (2013):***

In coordination with Utrecht University of the Netherlands, ICIMOD Nepal carried out first ever UAV based glacier studies in Lirung Glacier of Nepal. They also later conducted a workshop on the use of UAVs in glacier monitoring in 2015 (UNESCO, 2019).

### ***2.1.3. Academic research projects:***

Kathmandu University was leading research regarding use of UAVs in various potential fields like post disaster quick assessment, crop monitoring and biomass estimation, Kathmandu University (KU & CIMMYT, 2019).

A group of students from Kathmandu University carried out an academic study as a part of their thesis and assessed the accuracy of the UAVs in generation of high-resolution surface models in surveying and mapping work (Oli, et. al., 2015).

### ***2.1.4. Research and development of drones (hobbyists and enthusiasts):***

Various robotics clubs in engineering colleges and some independent hobbyists and enthusiasts were involved in development of drone prototypes. A technology startup company Engineering ADDA Nepal had worked alongside Nepal Army for over a year in 2014/15 in the prototype development of a defensive system against drones.

The mentioned activities refer to some of the documented usage of UAVs in Nepal prior to the earthquake. The major areas of focus were seen to be research and studies, and not for the professional/industrial applications.

## **2.2 Usage of UAVs during Nepal Earthquake 2015**

UAVs were widely introduced to the public and the government agencies in Nepal in the aftermath of the Nepal Earthquake 2015. After the seismic disaster hit Nepal, several humanitarian organizations, journalists and emergency responders used UAVs, mostly within the Kathmandu valley. Aerial photography and videography were done using UAVs in a large number of places mostly by aid workers for situational awareness. Large bird's-eye-view maps, technically termed as orthophoto maps, provided quality ground information like never before, helping a great deal to lots of people and organizations working in data collection, relief efforts and disaster response.

Following are the documented uses of drones in Nepal during the earthquake:

### ***2.2.1. Damage Mapping & Situational Awareness:***

Research institutions like ICIMOD, NSET and Kathmandu University used UAVs for mapping damages occurred from the recurring quakes in different locations (Baral, 2015).

A survey team including Nagoya University, Metropolitan University and the National Research Institute for Earth Science and Disaster Resilience used UAVs to survey the damages occurred in Langtang Valley.

Canadian UAVs maker Aeryon Labs, partner company MonaUAV of Monaco and the Canadian humanitarian aid organization Global Medic used UAVs to help aid relief operations during the earthquake by using UAVs to help photograph and map areas affected by the earthquake, and the information was passed to aid crews and rescue workers on the ground (BBC, 2015).

### ***2.2.2 Search and Rescue Operations:***

UAVs were also used by Nepal police and Nepal army in limited occasions and places, although the efforts were not scalable as they

did not have sufficient equipment, expertise and skills for the use of UAVs. However, the limited use of UAVs showed better situational awareness, relief and rescue operations and gave rise to the popularity of UAVs among responsible institutions and authorities.

### ***2.2.3. UAV Journalism and Story Maps:***

During the earthquake, several organizations started using UAVs particularly for photography and videography. With the international media making use of aerial images and videos for news coverage and reporting, the significance of such contents was highly felt and hence led to the increase in use of UAVs in Nepal afterwards.

NBC News which had used UAVs in international reporting a couple of times covered a story during the devastating disaster. Their belief was that UAVs can provide unique views otherwise not possible from any ground or other aerial means of capturing (Tompkins, 2015). News media agencies like AP Media Insights used UAVs for reporting.

The mentioned activities refer to some of the documented usage of UAVs in Nepal during the earthquake. The major area of focus has been using UAVs for better coverage of ground situation, situational awareness and surveying and mapping of damages.

## **2.3 Usage of UAVs post April 2015 Earthquake**

A lot of applications of UAVs were seen post-earthquake. Some significant applications of UAVs post-earthquake in Nepal have been mentioned below:

### ***2.3.1. Surveying and Mapping to aid reconstruction efforts:***

UAVs were used in inspecting areas and preparing maps and utilities to aid in the reconstruction efforts. The high-quality maps and photos obtained from UAV based surveying made it possible for preparation of

village/community relocation plans and master plans quickly and more effectively. Among several humanitarian agencies working to support reconstruction efforts, a US based nonprofit agency Build change was leading several drone mapping related initiatives to map earthquake damage, create time series progress of reconstruction works and high-resolution maps for resettlement planning (Zechar, 2017).

### ***2.3.2. Hazard Mapping:***

A joint research team from the University of Michigan, University of Southern California in the US and Tribhuvan University in Nepal used UAVs in Earthquake induced landslide mapping efforts which otherwise would have been almost impossible owing to the steep topography and large size of landslide at few places. A humanitarian organization Medair, together with Nepal Flying labs, carried out mapping of a huge landslide in Ramechhap district to assess the potential risk of the landslide in locations where new houses were being built (Pudasaini, 2017).

### ***2.3.3. UAVs for Humanitarian and Crisis Mapping:***

A first of its kind training titled “Professional UAV training for Disaster Preparedness and Recovery” was held at Kathmandu University in September 2015 jointly by UAViators (humanitarian UAV network), Kathmandu University, Kathmandu Living Labs (a local civic tech institution), DJI (leading UAVs manufacturer) and PIX4D (leading UAV data processing company). The team together with Panga (Kirtipur) also did a UAV based survey of the affected community in Panga-Kirtipur, printed a flex map and shared it with the Community Disaster Management Committee (CDMC), Panga. A group of 30 Nepalese individuals from different sectors were trained in the use of UAVs for post disaster mapping and data processing. This marked an epoch in the brewing of many local professionals using UAVs for crisis mapping and humanitarian response in Nepal (GSW, 2015, Soesilo, 2015,

KU, 2016).

#### ***2.3.4. Establishment of first ever local expert center on UAVs:***

Following the first UAV training in the UK, a significant milestone was achieved which was the establishment of a local entity to take forth similar activities and create a favourable ecosystem around the use of UAVs and robotics in Nepal. An international organization, WeRobotics, established the first ever Flying labs - Nepal Flying Labs to localise UAVs and suitable robotics solutions by the capacity building of local experts in Nepal so that the local experts here can use these solutions in a sustainable way. Nepal flying labs since its establishment has been leading several UAVs based social good, humanitarian projects and also advocating for a favourable environment around UAV use in Nepal (Meier, 2016).

#### ***2.3.5. Establishment of UAV based service provider companies***

As a milestone in terms of creation of a UAVs based market in Nepal, a company named Dron Nepal was initiated shortly after the Nepal Earthquake 2015, with their sole focus on the usability of UAV technology in various application areas in the context of Nepal, as well as sensitization and capacity-building programs to enable the UAV ecosystem to grow. Since then, Nepalese market has seen the growth in private businesses making use of drones in many diverse applications of UAVS, and many existing companies adopting drones in their workflows. Some other companies like Abhiyaan, Airlift Nepal, Madhuka are providing drone related services (WeRobotics, 2017).

#### ***2.3.6 Agriculture:***

Different agencies and institutions like ICIMOD, Himalayan College of Agricultural Sciences and Technology, Kathmandu University, Mercy Corps Nepal and CIMMYT Nepal have been implementing the use of UAVs in the agricultural sector for research studies. We are yet to experience professional usage of UAVs in the sector.

#### ***2.3.7 Rural Healthcare***

In rural Nepal, one of the biggest challenges for healthcare is the lack of an effective transport infrastructure. Healthcare workers or patients have to take hours-long walks to reach healthcare services, and many a time, the essential supplies get out of stock.<sup>[20]</sup> A UAVs based approach towards facilitating rural healthcare in Nepal was introduced in the form of a pilot project in 2019 namely Drone Optimized Therapy System (DrOTS) that aims to improve access to healthcare access in rural villages of Nepal. With support from WeRobotics, Nepal Flying Labs and Dron Nepal teamed up with Stony Brook University, BiratNepal Medical Trust (BNMT), the Liverpool School of Tropical Medicine, the Ministry of Health and Population (MoHP Nepal), the National TB Center, the District Public Health Office (DPHO Pyuthan) and the Simons Foundation to bring expertise in cargo drones to this significant public health project (WeRobotics, 2019, The Nepali Times, 2019). The project has already concluded its first phase successfully in Pyuthan, and now is on the works for the second phase with scaling to other areas in its work plan.

The aforementioned activities refer to some of the documented post-earthquake usage and milestones of UAVs in Nepal. The major focus however has mainly been in three sectoral areas: aerial photo/videography for media and filmmaking, surveying and mapping and, research and development on use of UAVs.

### **3. UAV REGULATIONS AND REGISTRATION**

#### ***3.1 UAV Directives***

The increase in the usage of UAV forthwith the earthquake invited a lot of concerns from the Government of Nepal. While UAVs aided a great deal to the numerous foreign and local volunteers, aid workers, and international and national media agencies, dedicatedly working in different ways from data collection to

relief operations, few of the UAV operators were caught flying UAVs in highly sensitive areas such as world heritage sites, historic artefacts, military peripheries and police stations. The Government of Nepal realized the consequences of the unregulated use of UAVs and the Ministry of Home Affairs expeditiously released a set of strict UAVs guidelines. This greatly limited the use of UAVs in Nepal and resulted in a decrease in the rate of adoption of the technology for humanitarian causes. The first UAV directive of Nepal was released in May 2015 by the Civil Aviation Authority of Nepal to regulate and systematize the operations of UAVs within the territory of Nepal. It was designed in a very short time and as a result it came out a bit too vague. Nevertheless, it was appreciable at the time owing to its utmost need in regulating the UAV operations post-earthquake. The directive required taking permission from multiple ministries and authorities for each project and restricted the flight operations at specific locations for specific periods as permitted (CAAN, 2015).

Different government agencies have different concerns from their aspect regarding the use of UAVs as follows:

- The Civil Aviation Authority of Nepal (CAAN) is concerned about the safety as they believe unregulated UAV operation possesses high level security threats to aircrafts, weakens air safety and encroaches personal privacy.
- The Ministry of Communication and Information Technology (MoCIT) is concerned about the regulated use of frequency by UAV's communication systems that might interfere with the communication devices used by national security personnel.
- The Ministry of Home Affairs (MoHA) is concerned with the security and safety of the general public, and the security of their privacy given the fact that high resolution images can detect very minute ground features. Since UAVs originated as

military warheads and spying mechanisms, MoHA's concerns are commendable and necessary.

Although UAV permissions for almost two years remained tedious, post-2016 saw a rise in the number of private institutions and organizations using UAVs professionally. Later in February 2019, MoHA finally published a Remotely Piloted Aircraft/ Drone Related Flight Procedure, <sup>[23]</sup> which made it comparatively easier for professionals to use UAVs. The authority to provide flight permissions has since been delegated to the local government for the most popular categories of UAVs, hence making it much more convenient and faster for people.

### 3.2 UAV Registration

The MOHA Remotely Piloted Aircraft/ Drone Related Flight Procedure has categorized UAV into four specific types and has also introduced the provision for registration of UAVs from CAAN. As per the directive, all types of UAVs must be registered for a Unique Identification Number (UIN) with CAAN. UAVs are classified according to weight, purpose of flight and sensitivity of risk of flight operations viz. Category A, B, C and D (Dalamagkidis, 2015).

Table 1: Per category total number of UAVs registrations till March 2020  
\*information obtained from CAAN

	Weight of UAV	Risk of flight operations	Registered till Date
A	<250gm	Very low	15
B	250gms to 2 kgs	Low	129
C	2 kgs to 25 kgs	Regulated, Low	10
D	>25kgs	Regulated, High	0

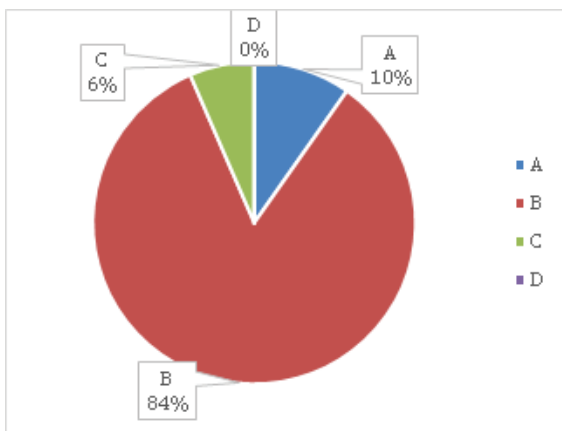


Chart 1 : Percentage of different category registered UAVs till date

An application needs to be submitted to the Flight Safety Standards Department, CAAN for the UAV registration for any one of these categories. The application package includes personal details or company documents with purpose of operation, details of purchase, custom clearance document and technical specifications of the UAV.

#### 4. EXISTING AND PROSPECTIVE UAV APPLICATIONS IN NEPAL

##### 4.1 Aerial Photography and Videography:

Nepal is home to many floras and faunas, and is the second richest country in water resources. Due to its diversity in topography, biology and climate, Nepal is considered as a rich country in terms of natural beauty. Aerial means of photo/videography is an effectively crucial means for capturing its true beauty. Use of UAVs in Nepal for photography and videography traces back to almost a decade, however, the rise in its popularity has been after the earthquake. Since then, the use of UAVs in photography, cinematography and media has risen exponentially.

**Benefits:** Aerial videos and photos help to capture bird's-eye-views of locations which is not possible and/or feasible with traditional methods. It's also much more flexible, cheaper, convenient and accessible than aerial photography using helicopters and planes.

**Challenges:** The process for securing permission for aerial photo/videography is the same as of any other professional application. Owing to the context and risk scenarios relating to the use of UAVs in photo/videography, the permission process needs to be more flexible and convenient since UAVs have democratized the professional aerial photo/videography, enabling not just media companies but also individual professionals to use them.

Licensing and regulation of UAV pilots is also required as the number of UAV pilots is rapidly growing without any quality check.

##### 4.2 Surveying and Mapping:

About 70% of Nepal's topography is rough, and topographical surveying has a huge drawback owing to inaccessible locations, high risks to surveyors and equipment with the use of traditional tools and technologies. Also, being an underdeveloped country, Nepal has significant requirements for quality data driven development, hence giving rise to a need for a better intervention in surveying and mapping. As such, UAV technology has a huge scope in the said area in Nepal. The most popular types of surveys in Nepal are: land surveys, road surveys, hydropower surveys, as-built surveys, sewer and canal alignment surveys, transmission line surveys, etc. Also, a number of government agencies like the Survey Department, Nepal Electricity Authority, Department of Mines and Geology, Department of Roads and many newly formed local government units have prioritized use of UAVs in some of their projects, and recently in 2019, The National Surveying and Mapping Agency of Nepal also procured UAV for surveying and mapping.

**Benefits:** In comparison with traditional topographical surveying techniques, UAV photogrammetry (referring to capture of photos/videos along with measurement data) is cheaper, faster and more accessible, and helps generate several high-quality mapping products with details up to millimeters level

(Beretta, et. al., 2018). The UAV mapping could be delivered in less than 20% of the turn-around time that a conventional approach would have required (Volkman, 2017).

**Challenges:** Most common and affordable UAVs in the market rely on RGB cameras/sensors and are unable to provide quality data over areas with dense vegetation cover. In Nepal, a majority of areas are covered with vegetation, and the alternative lidar-based UAV technology to be used in such cases is highly expensive, hence making it challenging.

#### 4.3 Disaster Response and Management:

Frequent multi-disasters in Nepal's difficult terrain makes disaster management a huge challenge and it is imperative to have up-to-date geospatial information. UAV enabled highly portable and quick-to-deploy alternatives for situational awareness to aid with efficient disaster planning and management. The high-resolution aerial imageries captured from drones can be utilized to create detailed maps that can in turn help in contextualizing the disaster management plans and responses.

**Benefits:** The high-quality maps and outputs produced from UAV based mapping enable efficient response plans and also encourage better coordination among various response teams and agencies.

**Challenges:** Using UAVs nowadays is much easier, but the unregulated use of UAVs without considering the privacy of people as well as the negative impacts of its use on people and communities leads to further damages in addition to the disasters themselves. We still lack a disciplined and regulated approach towards humanitarian responses using UAVs.

#### 4.4 Rural Healthcare:

UAVs are far less time consuming than having to travel by foot, or through dangerous winding roads in mountains. It can be a very efficient tool to connect primary health facilities to more equipped hospitals by delivering patient

information such as blood, urine and stool samples required for diagnosis from primary facilities to hospitals; and medicines from hospitals to patients in nearby rural locations in remote villages of Nepal. The problems with connectivity among health facilities, diagnostic laboratories and well-trained personnel, as well as with the access to basic medicines at the time of emergencies can be ameliorated efficiently and cost-effectively through UAVs. Different organizations have been trying to implement UAVs for rural health programs in Nepal.

**Benefits:** Efficient solution for connecting most rural communities in Nepal with essential medications and health services during emergencies where access to healthcare facilities by road is very difficult.

**Challenges:** Long range deliveries and delivery of larger payloads present technical bottlenecks in implementation of UAVs. Also, due to a lack of local maintenance facilities and enough skilled manpower for UAVs, sustainably implementing such projects is still hard in Nepalese context.

#### 4.5 Urban Planning:

Nepal has only recently been federalized forming 7 provincial governments and 753 local governments, which are all prioritizing infrastructure development and planning. All these cases lead to a necessity of high-quality data and tools assisting in proper planning, and hence UAVs and related technologies possess huge significance in Nepal. Firstly, the dense urban clusters can be mapped in high resolution and spatial footprints of the utility structures could be derived that could help in proper planning development activities. Secondly, the urban sprawl could be made much more efficient through planning based on such high-quality data.

**Benefits:** High resolution spatial data from UAVs aids in proper planning in case of dense clustered areas. These data and utilities also



reduce the redundancy of needing to conduct multiple kinds of surveys in the same area for different development purposes.

**Challenges:** Securing necessary permissions to fly over dense urban clusters is a huge challenge in Nepal, and also poses risks to people and infrastructures if done without proper security measures. Also, the UAV market is still in its infancy in Nepal, and hence creates hardships in scaling up mapping activities nation-wide.

#### 4.6 Agriculture:

Nepal is an agricultural country with involvement of 65% of its total population in agriculture and contributing to almost 32% of its total GDP. The public in Nepal have agricultural land ownership mostly in segregated clusters here and there, resulting in a fragmented farming system. Their reliance is on traditional tools and technologies that age decades if not centuries, and hence have a dire need for disruption through technologies in many aspects.

UAVs equipped with different multispectral sensors can be used in collecting data that could help with better assessment of crop health, irrigation needs, farming management needs, etc. With the right government policies, programs and support to encourage advancements in agriculture, UAVs could really disrupt the way farming is done in Nepal, moving towards precision and data-driven farming from traditional farming.

**Benefits:** Detailed data from UAVs equipped with multiple sensors could help in higher yields through data driven farming and agriculture.

**Challenges:** Many farmers in Nepal have small land areas located in multiple locations also called as fragmented farming systems, which makes use of UAVs costlier. Also, the technical capacity of such farmers is much limited, hence making it difficult to implement

locally sustainable UAV based approaches.

#### 4.7 UAVs for Glaciological Studies:

Glaciers are an important indicator of climate change and changes in glaciers need to be monitored and studied on a regular basis. Satellite images are usually low in resolution due to cloud covers affecting the quality of data at such high altitudes, where glaciers are found. This establishes UAVs as important tools in data capture in such high-altitude areas to obtain high resolution images, thus helping a great deal in extracting different information of the glaciers and its surrounding like the rate of ice melting, changes in supraglacial lakes, changes in the geometry, area, etc.

**Benefits:** UAVs enable collection of data over large stretches of area in shorter time. They are operated below clouds hence solves the problems of data loss due to cloud covers in satellite imageries.

**Challenges:** Mapping very high-altitude locations requires special UAVs which are relatively expensive. Such drones are usually short-ranged, hence requiring the piloting team to be present at the site physically, hence making the mapping projects harder and time consuming as the teams need to trek for days just to reach the sites.

#### 4.8 Biodiversity conservation and ecological monitoring:

Nepal is a richest country in biodiversity and hence regarded as a biodiversity hotspot. A lot of efforts and projects have been in the field of biodiversity conservation in Nepal since ages which is home to lots of floras and faunas, many endangered animals like one-horned rhinos and many unique to its environment like spiny babbler, Nepali Kalij, etc. UAVs equipped with different optical and multispectral sensors can be utilized in biodiversity and environmental studies for applications like wildlife monitoring, forest biomass estimation, counting and tracking various endangered species of animals in national parks and wildlife reserves, etc.

among others.

**Benefits:** UAVs provide quicker, cheaper and faster-to-deploy solutions to wildlife monitoring and conservation efforts.

**Challenges:** Multi-spectral sensors are expensive and also professional UAVs used in this kind of application are not readily available in Nepal.

#### 4.9 UAV/Drone Journalism:

Journalism over the past few years has seen a rapid increase in the use of UAVs in Nepal, especially following the earthquake, where lots of national and international media used UAVs for news footage. Pahilopost.com, an independent news portal in Nepali language is the first media in the country to use UAVs for gathering news since April 2015. Ever since, a majority of news agencies have opted to use UAVs in at least a few of their coverages. The Nepal Flying Labs along with Photojournalist Club organised a one-day interaction session on UAV Journalism to sensitize around the use of UAVs in journalism. Use of UAVs is much more efficient and feasible for aerial media coverage instead of costlier alternatives like helicopters and balloons, and the ease of use of UAVs also makes it superior to other methods. While UAV journalism is still in infancy in Nepal, it has lots of scope and it is also growing day by day in use.

**Benefits:** UAVs provide aerial views with much higher flexibility in operation and reduced costs compared to other means of aerial photo/videography, which has enabled even small media companies to make use of UAVs.

**Challenges:** Nepal still doesn't have licensing policies for the regulation of UAV in journalism. Also, due to the democratization of aerial photo/videography by UAVs, we are prone to more privacy and security issues in lack of efficient regulations and monitoring systems.

Apart from the applications discussed earlier, there still are a few more applications in the context of Nepal. The national security agencies are using UAVs for surveillance. UAVs are being used most of the time during visits of VIPs and also for the surveillance of some busiest streets in the valley. Different innovation hubs, groups of young college graduates, student clubs in colleges and schools have started integrating UAVs as a part of their interest, educational assessments and have been trying to use it across different sectors. Many companies and organisations have also been using UAV generated data in combination with AI and other technologies to produce amazing results in many sectors.

#### 5. MARKET CHALLENGE FOR DRONE INDUSTRY & SUGGESTIONS

While the applications of UAVs have gained momentum over the years, a lot of factors still pose great challenges to the UAV industry that need to be resolved in order to facilitate greater adoption of the technology in Nepal. Some of the challenges and corresponding suggestions could be summarized as follows:

**Hardware issues:** There are no UAV manufacturers in Nepal, and all the UAVs being used professionally are imported from abroad. Since UAVs are highly prone to damage owing to the undulating terrain, UAV accidents are very likely in Nepal. Since only few UAV repairing shops are available in Nepal that are able to handle just basic replacements, it's much tedious and costly to get the UAVs repaired in case of serious damages where the only option is to send UAVs abroad.

**Manual Registration process:** While there have been few positive changes in the recent UAV directives, few crucial mechanisms are yet to be implemented like the digital registration process, provision for monitoring and surveillance of UAV flights and approvals of UAV pilot institutions, registration of drones without purchase documents (those

purchased way back, or the ones donated by foreign institutions/individuals).

**Drone licensing policies:** There are no provisions for UAV pilot licensing in Nepal, and no institution or individual can hold a license for UAV piloting. This has negatively impacted the market standard in terms of quality of drone services, as well as made it tedious for professionals to rapidly use UAVs.

**Inefficient Permission Procedures:** With the current permission regulations, there are many aspects that adversely impact the use of UAVs in Nepal. Firstly, lacking a one-door policy, the permission process is still tedious and time consuming in many cases. Although the permission process is more systematic than before, the entire process is manual which needs to be digitized and improved.

**UAV insurance:** Drone insurance is mandatory as per the guidelines for flight permission. Only 3rd party insurance is possible and feasible but it is extremely challenging and difficult to insure UAVs currently in Nepal.

Seeing the significant increase in the use of UAVs and its evolution in Nepalese Market, it is recommended to the government of Nepal to dedicate a priority unit to regulate the UAVs instead of distributing the authority to the CAAN and the MoHA's existing departments. Standardization in pricing- UAVs are very easy to fly, anyone with some online training could fly a drone. There is no competitive authority to set all the standard pricing, standard for human resources etc.

## 6. LIMITATIONS OF THE STUDY

This study is based on the documentations available over the internet and few publications. So the facts relating to UAVs that have not been publicly available could be missing. The limitations of this study could be briefly listed as:

1. In the case of exponential and disruptive technologies like UAVs, exactly predicting

the trends and application areas is never possible as newer and better use cases keep emerging. While this study tries to portray the best possible representation of drone industry in Nepal, the context of the industry worldwide has taken higher leaps and hence this study doesn't portray the industry trends worldwide.

2. We haven't included the economic factor and availability of UAVs in the international market that also plays a role in the evolution of drone use cases in Nepal. A redundant issue with many application areas of UAVs in Nepal is due to the lack of proper infrastructure and skills to maintain and repair drones, which is not an issue in most of the countries.
3. This study lacks details on facts and figures relating to the Nepalese drone industry due to the lack of much data on the same.

## 7. CONCLUSION:

Prior to the April 2015 Earthquake, only a selected group of technology enthusiasts, researchers and organizations had been making use of the technology in Nepal. However, the use of UAVs during the disaster acted as a catalyst towards increasing UAV popularity and it significantly gave rise to its adoption in various applications, mainly by the private sector in Nepal. Even the government has started viewing UAVs as an imperative technology in some applications and has included its use in some ambitious projects of its own, while a large number of private, international and national organisations have been making use of UAVs as data collection tools for different applications. Currently, UAVs are used for aerial surveying, agricultural study, risks and hazards mapping, photography/videography, aerial surveillance, rescue efforts and medical cargo deliveries.

Though a new practice of decentralization can be witnessed in terms of giving local district governments the authority to permit flights of

UAVs, a proper system to track all permission requests and approved permissions all over the country is equally important. The beginning of a drone registration system to keep record of each and every drone in the country is a very important step in establishing drone industry but digitization of entire registration and permission process should be taken in parallel to properly document everything.

Additionally, in order to catch up with the fast-paced development of UAV technology, and ensure its contextualization and sustained application in Nepal, a much higher prioritization needs to be done in few of the areas such as proper technology transfer to the local people, capacity building of local people for sustainable UAV applications as businesses as well as for efficient surveying. Due to its rich diversity in topography, altitude, climate and biology, Nepal could be a central place for reverse innovation, helping countries and companies experimenting with cargo UAVs, drone deliveries, etc. Research, development and experiments are needed to be done for these various UAVs based solutions and to scale them to other regions.

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