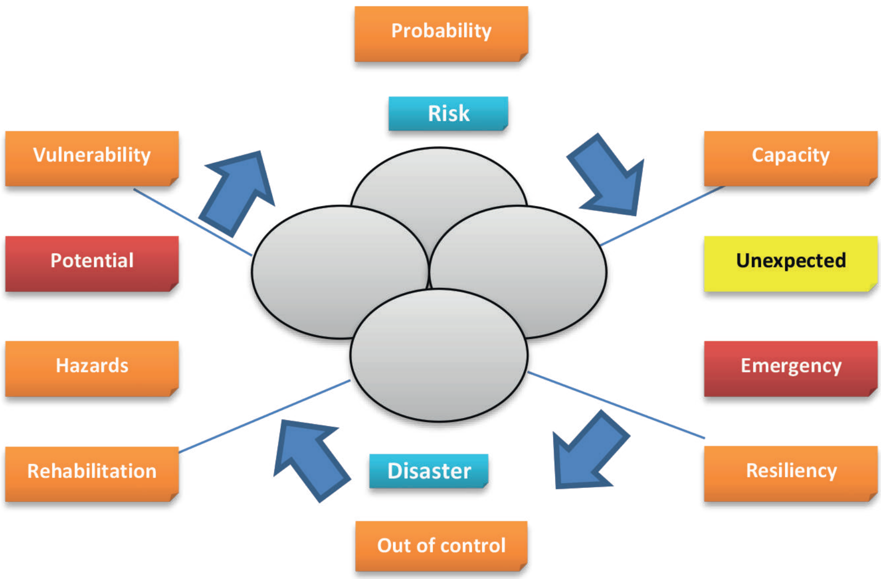

FIGURE 6.4
Architecture design of the disaster responses of the platform [1]

6.4 Geospatial Rapid Visual Screening for Earthquake Disaster Risk Reduction, Mitigation and Resilience

The modern space-based remote sensing integration with geospatial information technology has opened up efficient means for disasters risk reduction and resilience. The maximum economic casualties caused by natural disasters such as earthquakes, flood, tsunami, and landslide, between 1900-2018, occurred in Asia and the Pacific (https://reliefweb.int/map/world/major-natural-hazards-asia-and-pacific-0). Nevertheless, this section explains how geospatial information supports building inspection and safety for earthquake disaster risk reduction, mitigation plan and resilience.

In the context of SDGs, geospatial information rapid visual screening techniques can be interpreted in SDGs 11 and 13 in the aspects of disaster resilience, creating a safe and livable city and homes with the focus on housing condition. Geospatial rapid visual screening techniques allow screeners to determine the vulnerability of buildings and estimates risk with the potential to generate a 3D model for building and disaster applications beyond which it might be useful in building information management system (BIMS).

However, this technology aims to integrate geospatial technologies with engineering for risk assessment and 3D modelling utilizing computer vision techniques for disaster risk reduction, mitigation and resilience.It seems that implementing geospatial rapid visual screening techniques can strengthen the buildings, increase mitigation of hardware and software infrastructures for disaster monitoring and warning. It also supports a disaster prevention process within the context of SDGs 2030.

For exmaple, we attempted comprehensive sophisticated computing process to generate a damage index (DI) and building score utilizing the geospatial rapid visual screening technique with the Damage Index of Building (DIoB) algorithm and the Federal Emergency Management Agency (FEMA) approach [36, 35]. The damage index model (DIM) incorporation with geospatial information can be interactively utilized into the GIS to compute relevant engineering parameters for analyzing data and a better quality management on the web andcloud. Its resilience ability allows an easy accessibility of the geospatial data to evaluate buildings for earthquake mitigation and preparedness. This geospatial rapid visual screening techniques is a new combination of a geospatial integrated system and engineering disciplines for rapid evaluation of buildings, and for city planning by further combining GIS with building structural information, civil engineering and industrial engineering as required by the FEMA. All this in addition to the general information of the building, visualizing the 3D model of building, seismic data, soil data, land use data, structure, parcel, material type, foundation, ceiling, wall, floor, the interior and the exterior.

TABLE 6.1
Vulnerability scores on residential building

Score	Level of vulnerability
1–10	Demolishment
10–40	High vulnerability
40–70	Medium vulnerability
70–90	Low vulnerability
90–100	Invulnerability

6.5 Human Search and Rescue in Drone Images

The utilization of drones has become one of the recent good examples of such technologies empowered by machine learning and robotics.

Events, such as earthquakes, fires, floods, avalanches, and landslides occur all over the world. According to the Red Crescent instruction, the first and most important part of a search and rescue operation is to determine the location of injured people [14]. This stage can be very time-consuming, and

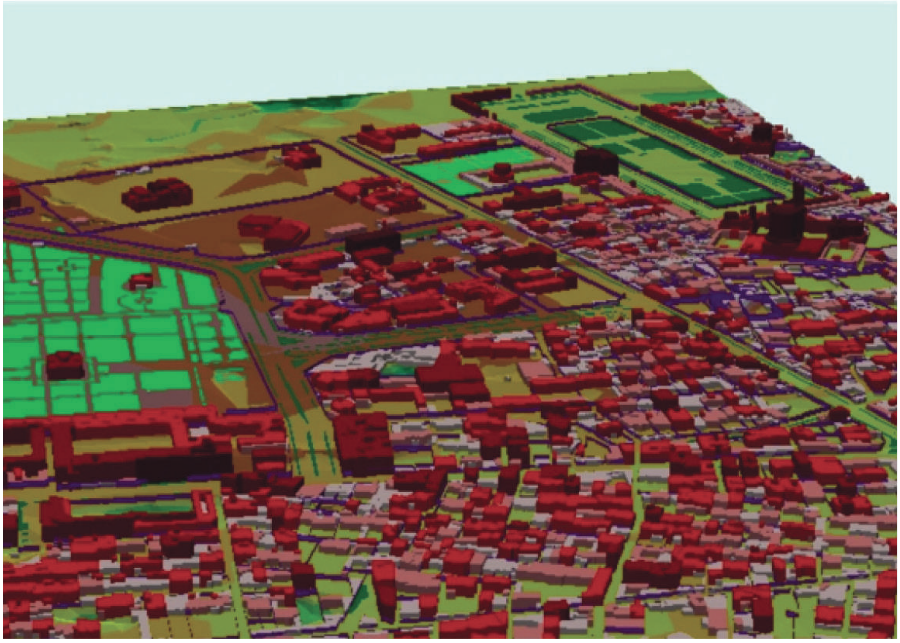

FIGURE 6.5
Most vulnerable buildings shown in dark red color

sometimes only a few extra minutes could be all that's needed to save the life of a person. In the event of avalanches, the use of trained rescue animals such as dogs is a common method, which, unfortunately, may not be enough to have a fast and accurate search operation [8].

Nowadays, with the advancement of technology, the application of intelligent relief equipment has become more possible than ever before. Therefore, the development of spatially enhanced tools that can automatically locate people in need of help is a key element for post-accident search and rescue tasks. In this context, drones are becoming very popular as they are capable of carrying out rescue missions automatically (Figure 6.7). In addition, they can perform tasks that may not be possible for a human operator to do such as collecting the required information without having to interfere with the working environment.

One of the major accessories used by such unmanned aerial vehicles UAVs are cameras. To date, a lot of research has been carried out on finding humans in images [2, 9, 28, 39, 29]. (2013)[12] reviewed the performance of the histogram of oriented gradients (HOG) descriptor in drone images and improved its performance for human detection. They considered the different viewing angles a person can be seen in a drone image. Following this, the Sector-ring Histogram of Oriented Gradients (SRHOG) feature [29] was developed. The

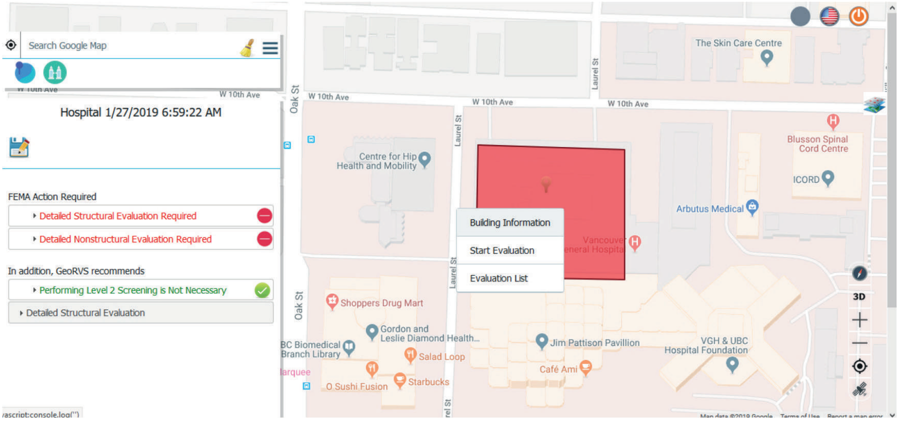

FIGURE 6.6
Recommendations of the building based on scores

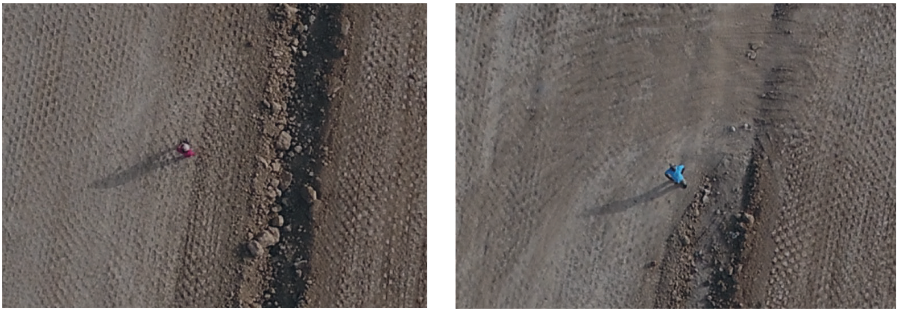

FIGURE 6.7
Sample images showing how humans may appear on drone images

SRHOG focus is to change the way the gradient is calculated making it more resistant to rotation distortions. It has also a different way of forming image blocks and interpolating their values. As a result, it is able to create a rotation-invariant feature. The robustness of this feature descriptor makes it a suitable to be used in drone images where humans are imaged differently with respect to those taken on the ground.

Later in 2018, the SRHOG was improved by adding two additional filters to the gradient calculation process [19]. One of the filters was used for calculating the gradient in the radial direction, whereas the other was applied along the tangential direction. This feature was also used to develop an algorithm for human detection within drone images. This algorithm takes an input (test) image and outputs the position of the injured person, if any. For this, first a pyramid of images is created, each of which has a different resolution. At each resolution, a search window is moved along various parts of the test image and the corresponding feature vector is computed. The result is, then, passed to a Support Vector Machine (SVM) classifier already trained with positive and negative images. An image is said to be positive if it contains all or part of a human body. Based on the training data provided, the classifier labels the test image with a positive or negative tag. If the image is positive, the location of the human is also delineated with a bounding box.

The new SRHOG-based feature was thoroughly evaluated using several data sets. The results suggested that the proposed method has a very good accuracy (90%) in situations where the human is either lying down or standing. Perhaps, this method can be used in a global scale for emergency response to support the SDGs 2030. However, it has a lower efficiency for sitting persons, as they appear very differently from above. It was observed that inappropriate lighting conditions can cause problems, and could be resolved to some extent using a preprocessing stage. In this context, an examination of the preprocessing techniques is required in future studies.

6.6 An Example of Lack of Laws in Geospatial and Environmental Issues

Governments need a set of binding legislation to regulate the relationships between their members and the environment, sometimes utilizing geospatial information technology and increasing spatial enablement [17]. This section briefly discusses an example of a lack of rules or inadequacies in the environmental and geospatial information field relating to agricultural-environmental issues and sustainability [15]. The detailed study by Ansari and Namadrian (2016)[5]; Arshadi and Pirasteh (2019)[6]; and (KWPA 2019)[27] showed that some environmental and geospatial regulations need to be revised or redefined more explicitly to reinforce their effects.

Today, the growth in population, irrational utilization of natural resources, biodiversity reduction, pollution and other causes of environmental destruction have impacted the world adversely, and for this reason geospatial information for achieving the 2030 SDGs has to play a significant role. The present quality of natural human life is a result of an unbalance and destruction of environment. It has led governments, organizations, and international communities to develop technologies such as geospatial information technology and to use them for disasters risk reduction and resilience. These bodies formulate and execute regulations to mitigate the environmental pollution and damages.

However, a case study attempted by Arshadi and Pirasteh (2019)[6]; and KWPA (2019)[27] have presented that the following are challenges and to be considered when the policy-makers decide to enrich the laws [26].

1. The authors determined that the traditional rules of environmental assess-

ments and data sharing, including geospatial information, are powerless. The provision of specific legislation in this regard is necessary.

2. The change in the legal sense "beneficiaries" and strengthening the role of non-governmental organizations are one of the most important strategies to support geospatial data sharing and protect the environment in the prosecution of cases.

3. There are no concrete and appropriate geospatial information regulations of data sharing. For example, during testing the geospatial rapid visual screening algorithms, we have not found adequate geospatial data of land use, seismic, soil and other relevant data for the city and building. Also, in one of the projects completed, there were severe challenges with collecting standard data for agricultural cadastral mapping and crop identification of Dezful, Iran (Figure 6.8). These included challenges such as flight permission and security when using drones for scanning the agricultural lands. Furthermore, during the agricultural cadastral mapping and crop identification of the Dezful project, it was concluded that there is no difference between drinking water and irrigation water, when distributing water. However, since the effects of contamination of drinking water are assessed much more robustly than contaminating agricultural water, the current existing law should have a clear definition of the law for all types of water.

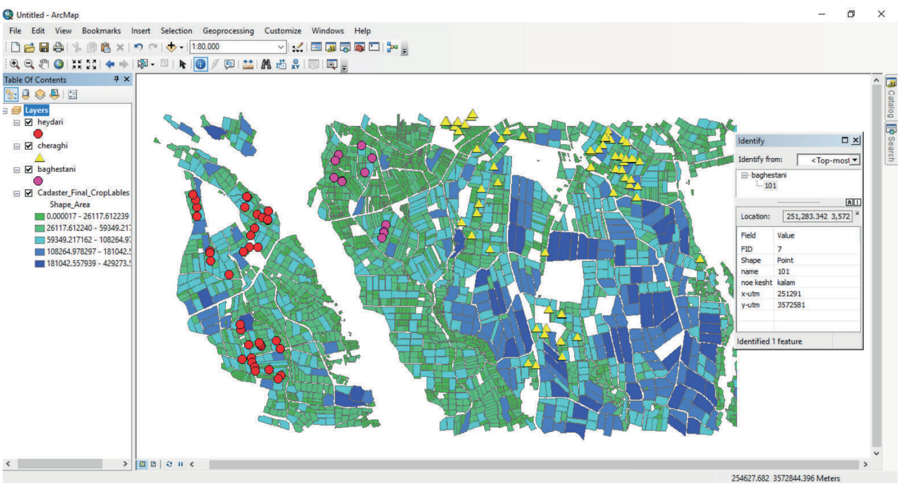

FIGURE 6.8
Agricultural cadastral mapping of Dezful, Iran

6.7 Conclusions and General Remarks

The world is shifting to the second data revolution and transformative technology by the means of geospatial information and geoanalytics utilizing computer vision and artificial intelligence. Therefore, this revolution will impact disaster risk reduction and mitigation, tremendously, by the means of data sharing via web and cloud-based platforms. There is a big change towards the Internet of Things (IoT), block-chain technology, various open sources, drones and many other technological tools in support of SDGs achievements. For this reason, to recommend building smarter cities, there is a need for people, intelligence and integrated technologies, including computer vision and AI for global challenges.

This chapter indicated that without applying the power of geospatial information technologies and integration with other technologies such as artificial intelligence and machine learning, computer vision, digital transformation, and multi-disciplinary research, there will be even greater challenges for future generations. Therefore, educating the young generation in innovative and cutting-edge technologies and research in geospatial disciplines through the Academic Network and understanding of the problems with the help of the private industry sectors at the UN-GGIM will help enable the SDGs implementation and monitoring. This chapter also presented examples of geospatial information and integration of technologies for earthquake disasters risk reduction and management to build a better world.

It is recommended that each and every country build and develop its National Geospatial Information Infrastructure (NGII) that can enable coping with disaster risk reduction and mitigation resilience. It is suggested that every country develop its architecture of GGIM with a strategic road map based on the global development policy of the 2030 Agenda and beyond. In addition educational resources should be allocated for emerging technologies of robotic and AI, enabling the making of maps and improving the cartographic workflow and the training of map makers. This is possible when all countries can access satellite images, needed for SDGs implementation and monitoring.

As discussed, in order to recognize humans in drone images using the integration of geospatial information and computer vision associated with artificial intelligence, it is necessary to describe objects using proper features. In this context, there are several challenges such as the existence of various objects and complex backgrounds. The flexible nature of the human body leads to numerous situations. Different viewing angles and different dimensions related to distance from the camera are other challenges that most algorithms face. The environment in which the image is taken also affects how the injured person appears on the image.

Finally, there is a clear lack of environmental and geospatial information laws and regulations. In order to move forward environmental and geospatial information laws need to be established or improved.

Acknowledgement

This chapter of the book is dedicated to the people at the United Nations who work on certain the new transformative 2030 agenda for SDGs 2030 and beyond. I would single out Dr. Amor Laaribi, the UN retiree and former UN-GGIM coordinator for reviewing the chapter and providing us with invaluable comments. Finally, the authors appreciate reviewers of this chapter for their remarkable comments.

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7

Application of Unmanned Aircraft Systems for Coastal Mapping and Resiliency

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This chapter provides an overview of UAS technology with focus on surveying and mapping. A case study on the use of UAS for coastal monitoring to aid community resiliency following a hurricane impact is also presented. The information and applications of UAS presented herein are applicable to a variety of UN SDGs including sustainable land use for "Life on Land" and sustainable agriculture for crop security and "Zero Hunger".

7.1 Introduction

Coastal zones are some of the most dynamic environments on Earth and some of the most threatened. According to the United Nations (UN) Atlas of the Oceans, 44% of the world's population (more people than inhabited the entire globe in 1950) live within 150 kilometers of the coast [2]. Growing population demand, impact from storms, climate change, and relative sea level rise puts coastal communities at the forefront of engineering and scientific efforts for sustainable and resilient development. As part of the UN Sustainable Development Goals (SDGs) for 2030, Goal 11 specifically identifies "Sustainable

Cities and Communities". In the context of coastal communities, resilience is a measure of the extent to which a coast is able to respond to external pressures without losing actual or potential functions [7]. Improving coastal resilience is considered to be a cost-effective approach to prepare for increasingly uncertain coastal environments. The ability to rebound more quickly can reduce negative human health, environmental, and economic impacts [5].

At a base level in building more resilient communities is the need for updated geospatial information. Coastal communities rely on adequate and timely geospatial data to guide decision-making in the event of a disaster, mitigate coastal erosion, and plan for sustainable development and growth. Emerging technology for the acquisition of spatially referenced data are rapidly transforming science, society, and decision-making. At the forefront of this revolution are technological advancements in unmanned aircraft systems (UAS), more commonly referred to as drones. UAS enable us to rapidly map and monitor our evolving world, with unprecedented detail, to tackle a range of problems in support of UN SDGs.

7.2 Overview of UAS Technology

UAS provide a new paradigm for aerial surveying and mapping. UAS are used to collect overlapping imagery, which can then be post-processed to derive two-dimensional (2D) and three-dimensional (3D) mapping products for geographic information. These data products can be used to characterize built and natural environments at a level of spatial detail previously unattainable or not practical with traditional remote sensing techniques. Spectral data can also be acquired from multispectral sensors onboard the UAS for performing traditional remote sensing tasks such as mapping vegetation health. Compared to traditional aircraft or satellite remote sensing, UAS provides certain advantages: rapid deploy capabilities, flexibility to target ideal weather conditions and for temporal repeatability, hyperspatial image resolutions, and cost-effectiveness at localized geographic extent [10, 12].

Application of UAS for surveying and mapping is primarily conducted with small UAS equipped with consumer-grade digital cameras and miniaturized sensors. Currently, the Federal Aviation Administration (FAA) of the United States classifies small UAS as weighing less than 25 kg (55 lbs) including payload. Often these platforms weigh only a few kgs with payload. UAS can be broadly classified into two types: rotary craft and fixed-wing (Figure 7.1).

Rotary craft typically provide more flexibility in sensor payload integration, enable more stabilized flight in windy conditions, provide vertical take-off and landing (VTOL) capability, and are better suited for inspection surveying (e.g. hovering), videography, and flying lower or slower to collect higher resolution imagery with reduced motion blur. In contrast, fixed-wing UAS