CHAPTER 1

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1.1 General

Coal can be excavated by opencast mining or underground mining method. Both methods have some advantages and disadvantages. Opencast mining processes damage the local vegetation and the forest ecosystems during the whole mining operations. Excavation of coal by underground mining method leads to subsidence that involves the vertical and horizontal movement in surface and subsurface strata. Subsidence may affect the surface structure, including vegetation and forest ecosystem.

Subsidence is a process in which there is a lowering of the ground surface in response to the removal of gas, liquid, or solid matters below ground, either naturally or man induced. Removal of any substance below underground leads to surface subsidence; however, it is more pronounced in case of shallow deposits. Coal deposits are sedimentary and comparatively shallow in nature compared to other minerals being extracted from underground. Therefore, most of the subsidence studies have been performed for underground coal mining working.

The magnitude and extent of mine subsidence depend on several geologic and mining factors (Henry 1957; King and Whetton 1957; Sinclair 1963; Cortis 1969; Brauner 1973; Chen et al. 1974; Anon 1975a and 1975b). The thicker the seam extracted, the larger the amount of surface subsidence. The peak value of subsidence decreases with increasing mining depth (Singh et al. 1990). The subsidence process is controlled by several other

factors, most of which are interdependent. These include mining method, depth of extraction, size and configuration of openings, rate of advance of extraction, seam thickness, topography, lithology, geological structures, hydrology, in situ stresses, rock strength, deformational properties, etc. (Geological Survey Circular 1982).

The extent and effect of subsidence can be understood by subsidence profile curve shown in Figure 1.1. Vertical displacement and strain curves are shown in this figure. Central concave part produces compressive strain while the terminal convex part produces tensile strain. On the basis of this, the compressive strain zone and tensile strain zone could be identified.

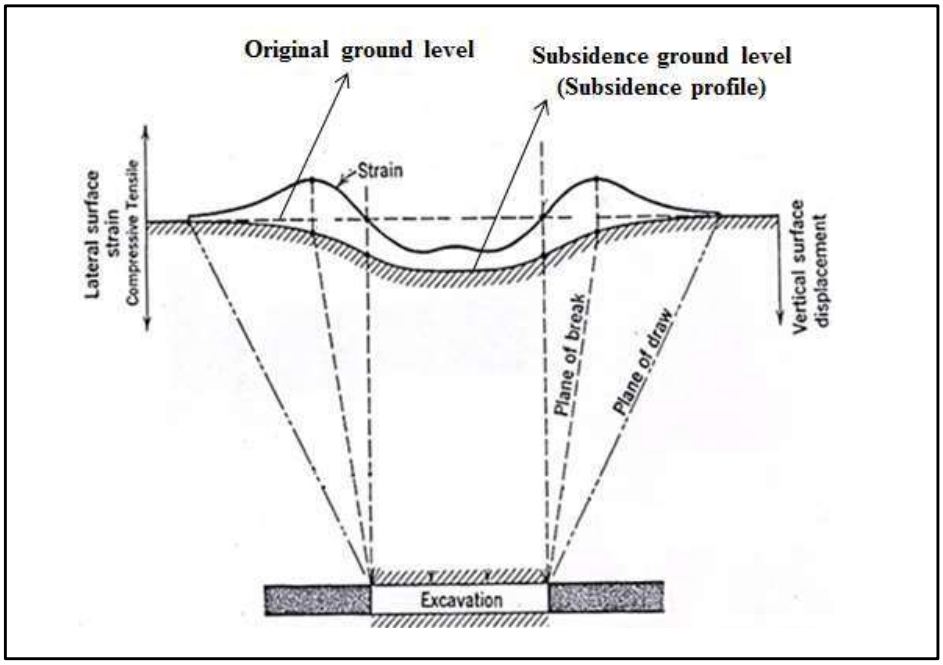

Figure 1.1 Subsidence profile of surface due to extraction of coal (Source: edurev.in)

Rocks are very weak in tensile strain condition while comparatively strong in compressive strain condition. Cracks are developed due to tensile strain. The damages due to surface subsidence can cause the change in the surface slope, differential vertical displacements, and horizontal strains. Damage from subsidence over underground mines

has been a serious problem for many years and will become more widespread as the demand for resources, particularly coal, increases. Subsidence results into the damaging of the surface structures. The common surface structure likely to get damaged by subsidence are buildings, foundations, water bodies (dams, embankments, reservoirs, canals, sewers, and sewage disposal works), roads and highways, railway lines, pipelines, surface vegetation, etc.

With the exception of a few studies on plants, most of the surface structural damages caused by subsidence have widely been studied. The damages due to subsidence in various structures are visible in subsidence zone. Except for the physical damages, the damages in plants are not directly visible through eye. It is of common belief that there is little or negligible damage to vegetation due to surface subsidence. However, with increasing environmental concerns, it is now considered that the subsidence can partially or completely damage the local vegetation. This study focuses on the impact of underground coal mining on plants.

The convex surface in the subsidence profile has tensile strain leading to cracks into it. Some of the cracks are very wide. The tensile strain damages the root system of the pants. The water retention capacity of this zone also gets reduced. The change in surface profile changes the natural drainage system of the soil. It may alter the soil nutrients availability to the plant. Contrary to the tensile strain zone, the compressive strain zone has concave surface profile. This leads to accumulation of nutrients around the plants found in this zone. Moreover, the roots system is also under the compressive strain for a longer time. These phenomena may affect the health of plants.

Proper growth of vegetation depends on adequate availability of nutrients and water to plants from the soil as well as their healthy root system. However, it is very difficult to study the roots system individually in the field. Plant damage first manifests in leaf health. Moreover, the accumulation or drain off of nutrients near the plants is another important parameter. Keeping above in the mind, the present study is focused on nutrients concentration in soil as well as in the plants. It is relatively easy to study the different parameters in laboratory scale work. Various parameters related to plants health in compressive as well as tensile strain zones have been studied in this study. The remote sensing study has been performed to get an overall view of the impact of subsidence on plants health.

1.2 Objectives

The main objective of the study is to assess the effect of mining induced subsidence on the health of vegetation. Four sub-objectives have been decided to achieve the main objective.

a) To know the effect of the nature of strain on the health of plants.
b) To determine a critical value of the strain after which the growth of the plants gets adversely affected.
c) To know the effect of subsidence on available nutrients in soil as well as in plants.
d) Overall impact of subsidence (tensile and compressive strains) on the health of the plants.

1.3 Scope of work

a) An extensive literature review has been done on the effect of mining subsidence on vegetation. Important plant growth parameters required for proper growth and development of the plants were identified.

b) Laboratory model has been prepared for chickpea and wolf's peach crops to study the various growth parameters in subsidence condition. The effects of nature of strain in surface subsidence profile (tensile and compressive) have also been studied on growth parameters.

c) Field investigation of the study area has been carried out to study the impact of subsidence on plant health. Soil and plant leave samples were collected from subsidence affected zones (i.e., tensile and compressive zones) and a nearby subsidence unaffected zone. Physicochemical analysis (soil texture and nutrient content) of the soil samples and nutrient content analysis of the plant leaves samples were performed in the lab.

d) A holistic view of the impact of mining subsidence on plants health has been assessed with the help of remote sensing technology. Image processing was performed in ENVI 5.1 image processing software. NDVI (Normalized Difference Vegetation Index) was calculated for the years 2014 and 2016. The temporal change of vegetation was achieved for the years 2014 to 2016.

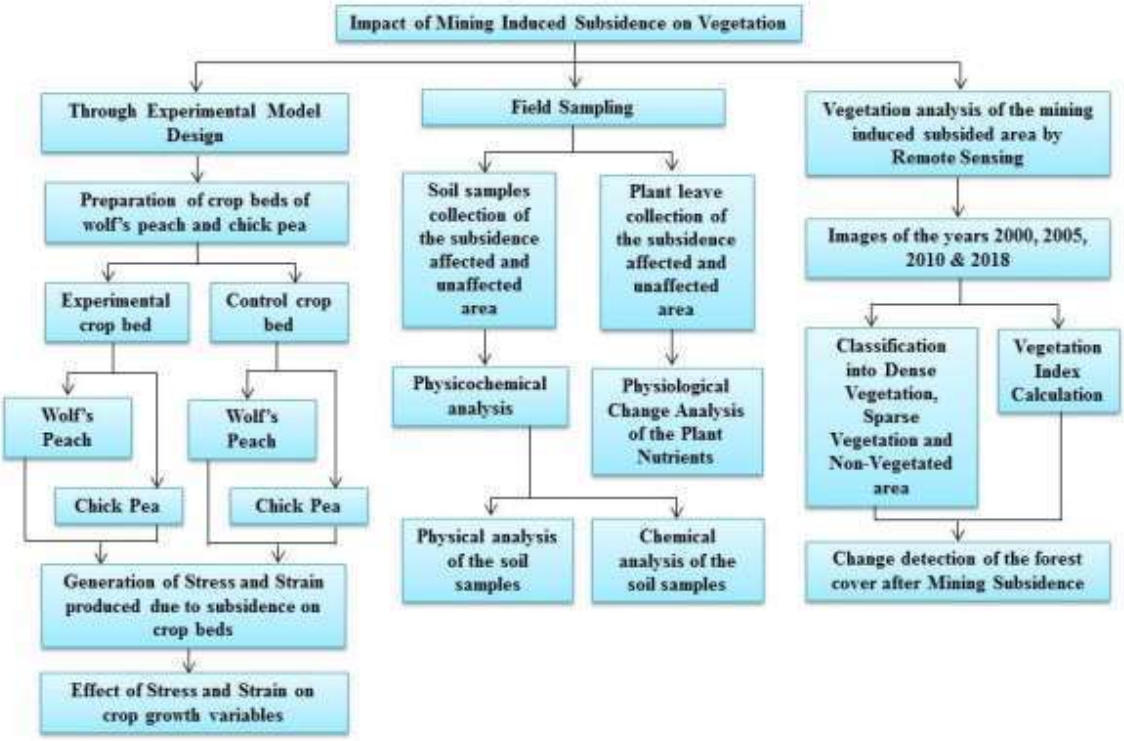

Figure 1.2 An overview of the methodology adopted for this study

Three different approaches have been used to achieve the above tasks. (a) The laboratory study (b) The field study and (c) The remote sensing study. Figure 1.2 shows the flowchart of the research approach for the present work. In the first approach, two types of crop beds, control and experimental, were prepared. Subsidence was induced on the experimental crop beds and effects of the strain on crop growth parameters have been measured. In the second approach, field investigation was performed for the assessment of impact of subsidence on the soil and vegetation by analysis of the soil and plant samples collected from the study area. The physicochemical analysis of the soil samples and nutrient analysis of the leaf samples were carried out in this approach. In the third approach, remote sensing technology has been used to assess the overall subsidence impact on plants' health.

1.4 Thesis Organization

This work shows the analysis of the health of plants on surface due to mining induced subsidence because of the excavation of coal from underground. Field study, experimental study as well as remote sensing study have been performed to complete the broad objective of the present work. The organization of this thesis is as follows:

Chapter 1 - This chapter describes the introductory background about the mining subsidence, scopes and objectives of the study and the organization of the thesis.

Chapter 2 - This chapter describes the brief review of some of the research work carried out for the assessment of impact of mining induced subsidence on soil characteristics and vegetation health by estimating soil physicochemical properties or plant physiological properties of the native areas.

Chapter 3 - This chapter describes the details about the experimental work carried out in the laboratory for the assessment of the impact of subsidence on vegetation.

Chapter 4 - This chapter includes the assessment of impact of subsidence on soil and plants through field study.

Chapter 5 - This chapter includes the assessment of impact of subsidence on vegetation by the use of remote sensing technology. The study was based on the NDVI calculation.

Chapter 6 - This chapter includes the conclusions of the research work of the present thesis.