APPENDIX C

RSDYK2008 - LITERATURE REVIEW

Contents

1 GENERAL CHARACTERISTICS OF PEAT

1.1 Introduction

Continues detection and monitoring of peat dykes is very important to secure their stability and protect the major impact on the environment and casualties (McCahon et al., 1987). Previous studies show that, there is still lack in detailed understanding of peat mass movements (Carling, 1986a; Dykes and Kirk, 2001). However, the hydrological and geotechnical conditions are the main issues of peat dykes. These conditions are usually affected by seasonal variations, which can be considered as a main cause of failure in many engineering structures (Tallis et al., 1997; Evans et al., 1999).

1.2 Peat as dyke foundation

Ward has been described the risk of a peat layer under a dyke (Ward 1948 and Ward 1955). He indicated that dykes founded on very weak peat might collapse within a short period after construction. Instability can occur in peat dykes even if they are on the top of an impervious material like clay (Carling, 1986a). This is because peat dykes can have less weight than the resultant water force especially when the crest of the dyke dries out (Van Baars, 2005). This resultant force can be affected by a rise of water level in the canals, ditch or streams.

1.3 Differential settlement

In countries with large peat deposits at surface such as Canada and Ireland, where peat covers as much as 16-18% of the area, construction activities face a serious problem to engineers with respect to the differential settlement and deformation. This is also a well-known problem in the test site area, Reeuwijk, The Netherlands.

1.4 Water content and homogeneity

The distribution of water content and total unit weight vary in both vertical and horizontal directions in peat layers. Saiyid (Saiyid Hassan, 1994); Dalton (1954) and Radforth (1964) postulated that, the retention of water in peat may be recognized as free water in large cavities, capillary water in narrower cavities and water bound (physically, chemically…). This indicated that any variability in the water content would affect the stability of peat structures.

In peat, the effective stresses and shear strength that are determining the stability are directly related to the water content. The water content of the topsoil varies with respect to the seasonal variations. Following the reduction of the water content of the topsoil during the dry conditions in the summer can result in drying and shrinkage of the peat layer. This will cause new cracking, reactivation of old cracks, and opening of peat fuel cuttings (Long, 2006). During the intense rainfall, water can rapidly percolate to the base of the peat through the new and old cracks. Therefore, any increase in stability due to lowering of the water content is likely to have been offset by the reduction in unit weight of the peat by drying. Pore pressures in the peat would have increased significantly, reducing the effective stresses and the resistance to sliding. It is also possible to speculate that repeated drying and wetting cycles caused shrinkage and swelling movements in the peat (Warburton et al., 2004). The soil moisture content is also a key parameter in computing the surface energy balance and important in many applications including hydrology, agriculture and meteorology (Petrone et al., 2004). Other factors like specific gravity, organic content, heterogeneity in soil texture, vegetation, land use, topography and surface temperature also affect the stability of peat dykes (Tansey, 1999; Li and Islam, 1999).

2 REMOTE SENSING

Remote sensing in all ranges of the electro-magnetic spectrum has many applications in geotechnical investigations (Figure 1). It is also used for mapping the top soil moisture over a varying landscape (Famiglietti et al., 1999; Li and Islam, 1999) and in identifying engineering structures. Rijswaterstaat, The Netherlands, has made an inventory of the possibilities of remote sensing applications for the purpose of dyke quality assessment (Swart, 2007). In this publication the possible options for using remote sensing are described based on a literature review.

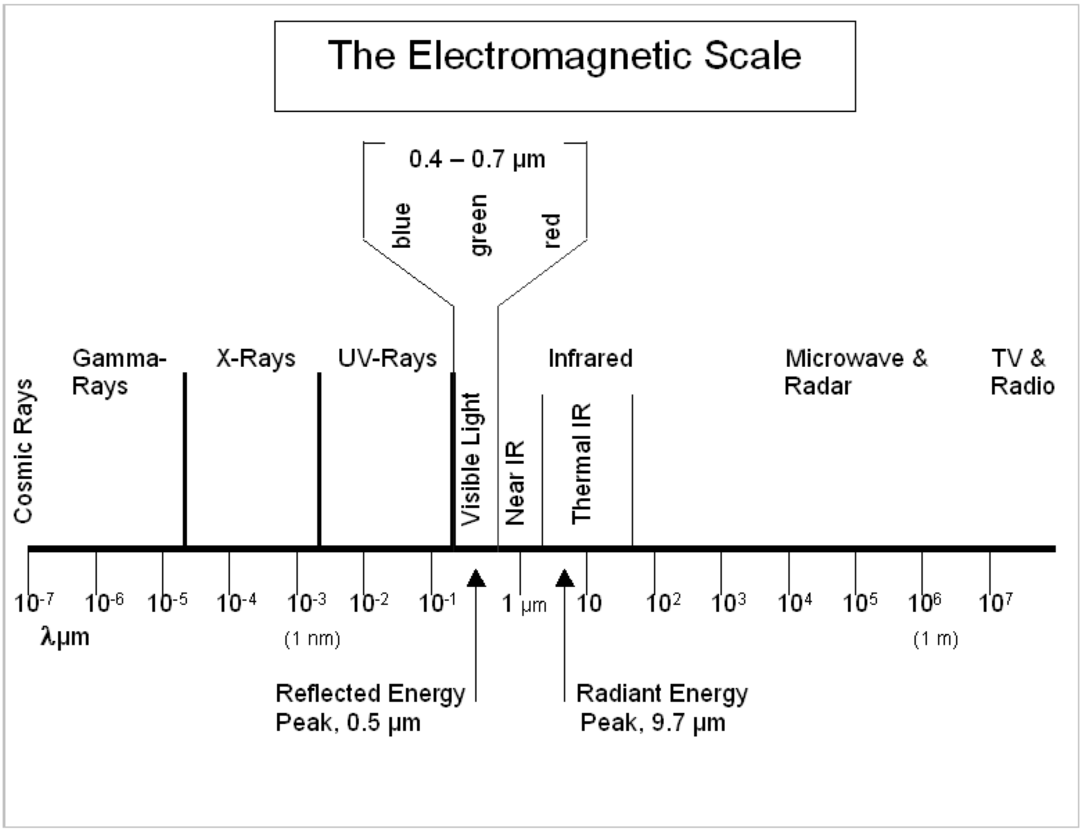

Figure 1. The electro-magnetic spectrum.

2.1 Thermal infrared

Thermal remote sensing is widely used for many applications including coal fire detection (Yang. 1995), dam leakage monitoring etc. Thermal remote sensing is based on the infrared range of the electro-magnetic spectrum. According to Planck's Radiation law, all objects above 0°K emit thermal electromagnetic energy in the 3.0 –14 µm wavelength region. The emissive power of a black body at any wavelength and temperature, as well as the amount of emitted energy per wavelength depends on the object's temperature. Different materials can have widely different values within the range of 0 to 1. The range of emissivity for ground components in situ of soil, vegetation and rocks, varies at a given wavelength according to their physical properties and water content (Fuchs and Tanner, 1966, Van de Griend et al., 1991, Blumberg, D.G et.al., 2000 and 2001).

Planck's law gives the spectral radiance of electromagnetic radiation at all wavelengths from a black body at temperature T as a function of wavelength λ:

$$M_{\lambda,T} \equiv C_1 \frac{C_1}{\lambda^5 \left(e^{\frac{C_2}{\lambda T}} - 1 \right)} \qquad [1]$$

In which $M_{\lambda,T}$ is the spectral radiance in (Wm^3), λ is the wavelength in (m), T is the temperature of the blackbody in (K), C_1 is the first radiation constant, 3.74151. 10-16 (Wm^2) and C_2 is the second radiation constant, 0.01438377 (mK).

The emissivity power increases with temperature at each wavelength and the position of the maximum emissive power shifts towards the shorter wavelengths. Relatively more energy is emitted at shorter wavelength (Figure 2).

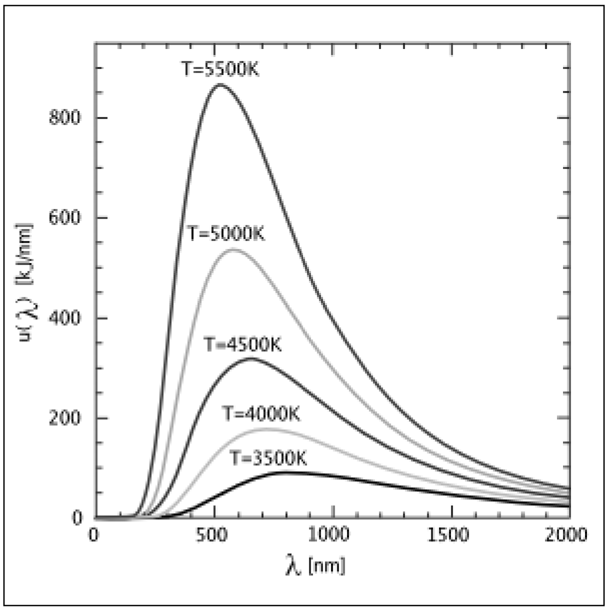

Figure 2. The blackbody curve at 3500, 4000, 4500, 5000 and 5500k

Many researchers (Idso et al., 1975; Reginato et al., 1976; Price, 1980) assessed and mapped soil moisture by thermal infrared using radar microwave technology, satellite images and/or airborne sensors for studying bio-physical processes on a micro-scale. Jackson (2002) showed the difficulties for retrieval of soil moisture due to the influence of surface variables like vegetation cover. Recent studies use terrestrial thermal remote sensing for detection purposes. Thermo tracer (TH9100) is one of the high sensitive radiometric cameras that measures the infrared radiation emitted from objects. Preliminary analyses using this thermal camera show a significant relationship between infrared-based temperature and surface soil moisture. At a small scale, the thermal infrared images by a thermo tracer is shown to be useful to map areas characterized by different soil moisture content (P.Mora, et al., 2007).

2.2 Reflectance features of vegetation

Changes in vegetation can affect the surrounding engineering structures and local groundwater level (Fredlund, 2001). A difference in the reflectance of grass, which covers a peat dyke, might relate to the soil moisture variation of the material. Remote sensing allows the detection of hazardous gas leakage of pipelines from the reflectance spectral signature of stressed vegetation (Van der Werff et al., 2007). The health of plants is reflected in its chlorophyll content (Van der Meijde et al., 2004). Adams demonstrated that healthy vegetation shows high reflectance in the green and NIR region (Figure 3). However, the chlorophyll of stressed or dry vegetation decreases its absorption efficiency and increase in reflectance in the red (Gausman 1974, Tucker 1979, Adams M.L. et al., 1999). Environmental factors such as soil, geomorphology and vegetation apparent roughness influence the reflectance values. Variations in climatic factors, in particular precipitation and temperature, have therefore a strong influence on variation in the reflectance.

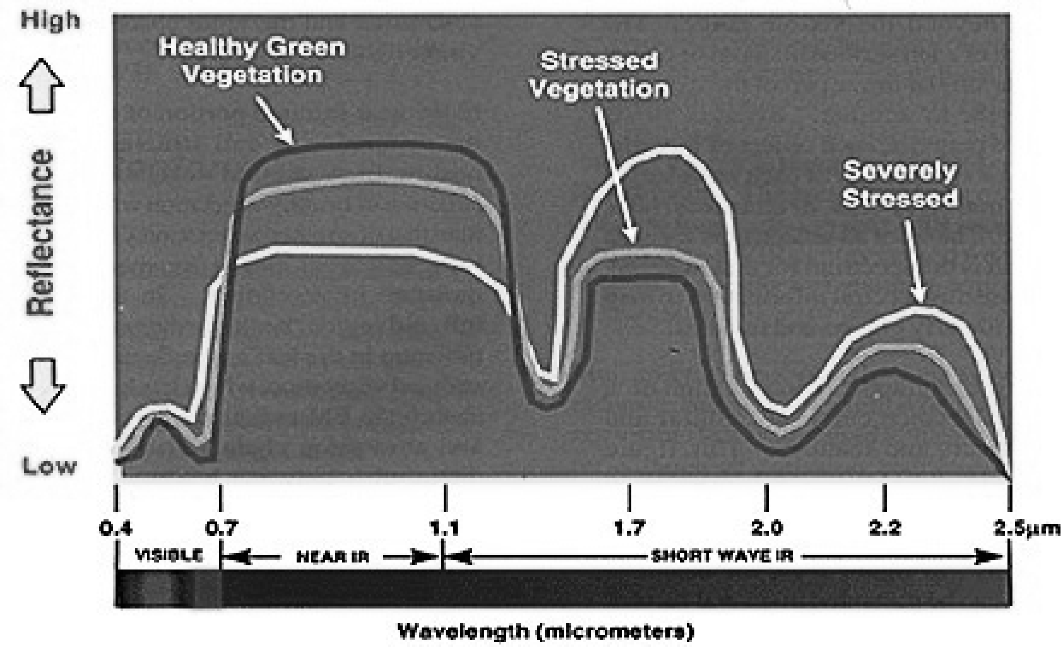

Figure 3. This general diagram shows the stress indicated by a progressive decrease in Near-IR reflectance accompanied by a reversal in Short-Wave IR reflectance

3 REFERENCES

For the references is referred to appendix N.