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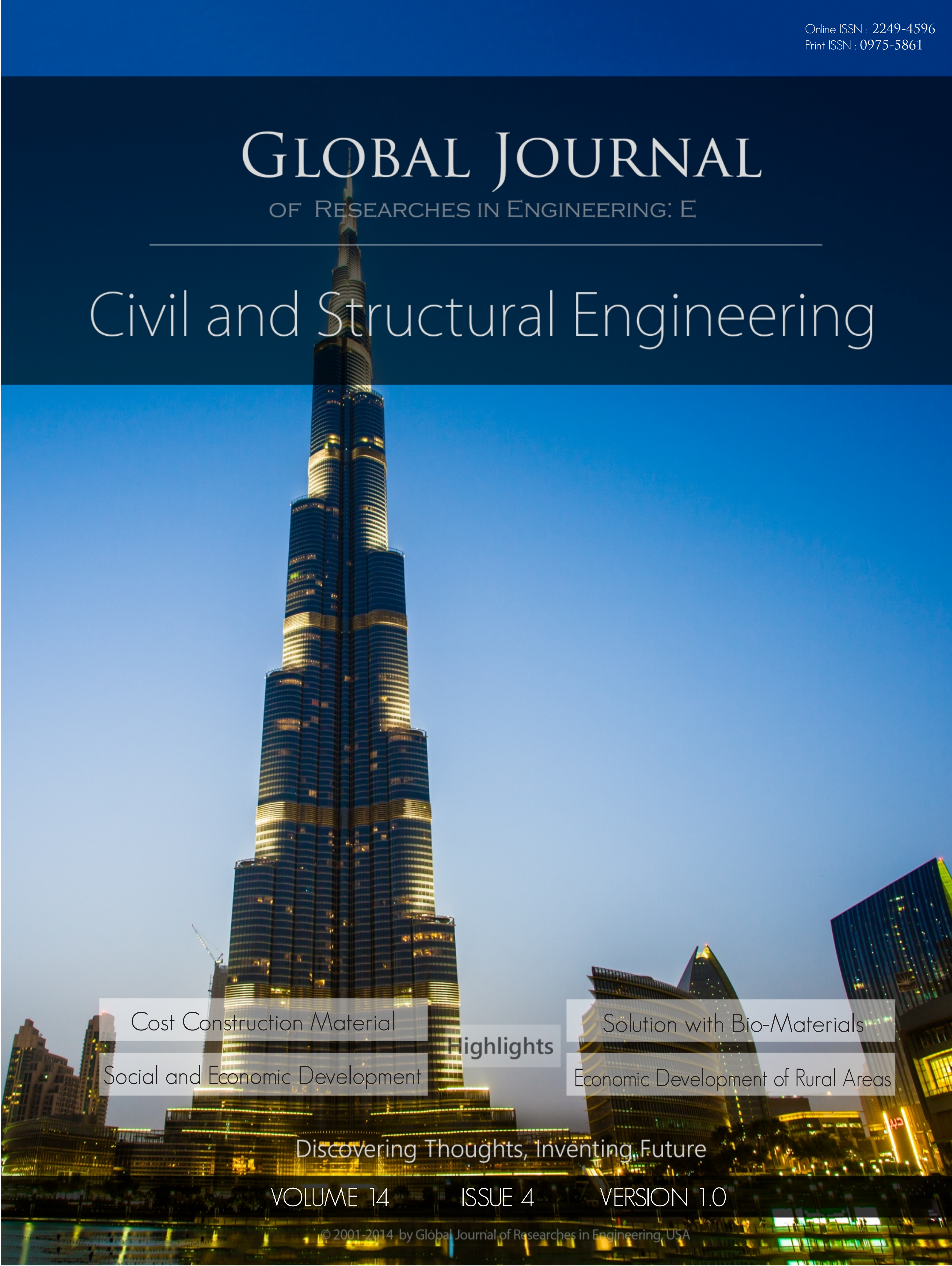

Highlights

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- Social and Economic Development
- Solution with Bio-Materials
- Economic Development of Rural Areas

Discovering Thoughts, Inventing Future

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Extension of the Consecutive Modal Pushover Analysis (CMP) to Asymmetric Concrete Moment Resistance Frame Buildings

By Babak H. Mamaqani
University of Texas, United States

Abstract- The Nonlinear Static Procedure (Nsp) Based On Pushover Analysis Is Usually Restricted With A Single Mode Response. The Nsp Is Valid Mainly For Low-Rise Buildings Where The Behavior Is Dominated By Fundamental Vibration Modes. It Is Of Significance To Take Into Account Of Higher Mode Effects In Pushover Analysis Of Such Structures As Tall Buildings Or Asymmetric Structures. Consecutive Modal Pushover (Cmp) Procedure Is Recently Proposed To Consider Higher Mode Effects In 2d Models. This Paper Deals With The Extension Of The Cmp Method To Asymmetric Building Structures. The Asymmetric Models Of This Study Are Reinforced Concrete Moment Resisting Frame Buildings. The Results Are Compared With Results Of Nonlinear Dynamic Time-History Analyses. Promising Compatibility Is Found In Both Local And Global Responses.

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Extension of the Consecutive Modal Pushover Analysis (CMP) to Asymmetric Concrete Moment Resistance Frame Buildings

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Keywords: pushover analysis, consecutive modal pushover (cmp), tall buildings, higher mode effects.

I. Introduction

According to the nonlinear static procedure (NSP), also known as pushover analysis, seismic demands of a building can be computed by pushing the building with a specific height wise distribution lateral load pattern to reach a predetermined target displacement. NSP's suffer from some shortages. Among them, invariant load pattern is one of the most important limits and it causes higher modes effects being neglected during pushover analysis. Besides, in original NSP's, all methods were limited to planar structural models and so, torsional effects are not considered directly and effectively. Recently, attempts have been made to overcome these limits and extend the applicability of simplified methods to asymmetric structures, which require a 3D analysis and consider higher modes effects in the analysis *e.g.* (Ayala and Tavera 2002), (Aydinoglu, 2003), (Chopra and Goel, 2004), (Fujii et al., 2004), (Yu et al., 2004) and (Zárate and Ayala, 2004).

This paper deals with the extension of the consecutive modal pushover (CMP) analysis which was proposed by (Poursha et al., 2009). The CMP procedure contains multi-stage and single-stage pushover analysis and is able to take higher modes effects into account. In the original version of the CMP method, 2D models were used and so, torsional effects were neglected. In the paper, the extended CMP method is summarized and applied to four ten story buildings with 0%, 5%, 10% and 20% eccentricities in Y direction. The results are compared with results of nonlinear response history analysis (NL-RHA).

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II. Discription of the Consecutive Modal Pushover (cmp)

The CMP procedure benefits from consecutive implementation of modal pushover analysis and uses limited number of modes to develop results (Poursha et al., 2009). This procedure contains a multi-stage and a single-stage pushover analysis. When the first stage of the multi-stage pushover analysis is performed completely, the next stage starts with initial structural state which is the same as the state at the end of the first stage. Numbers of modes which are considered in the multi-stage pushover analysis depend on the fundamental period of the structure. If the fundamental period of the structure exceeds 2.2 seconds, then, three modes shapes being used in analysis otherwise, two modes shapes would be enough. The displacement increment at the roof in each stage of multi-stage pushover analysis, u_{ri}, is calculated as follows:

$$u_{rn} = \beta_n \delta_t \qquad (2.1)$$

In which,

$$\beta_n = \alpha_n, \text{ for stages before the last stage} \qquad (2.2)$$

and,

$$\beta_n = 1 - \sum_{j=1}^{Ns-1} \alpha_n, \text{ for the last stage} \qquad (2.3)$$

Where δ_t is the total target displacement at the roof, and N_s is the number of stages considered in the multi-stage pushover analysis. Also, α_n is the effective modal mass ratio for the n^th mode, which is defined as the ratio between the effective modal participating mass for the n^th mode divided by total mass of the structure. The target displacement can be obtained through different methods e.g. capacity spectrum method (ATC-40, 1996), displacement coefficient approach (FEMA356, 2000), N2 method (Fajfar, 2000) and dynamic analysis of the structure (Moghadam, 2002). As mentioned before, the CMP procedure uses single – stage pushover analysis to develop results. Hence, a

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pushover analysis with a triangular or a uniform load distribution is performed separately. Seismic demands can be obtained by enveloping the peak responses derived from the multi-stage and the single-stage pushover analysis. The CMP procedure as proposed by Poursha (2009) is summarized below in a sequence of steps:

a) Calculate natural frequencies, ω_n and mode-shapes, ϕ_n. These properties are computed by Eigen values obtained from linearly elastic building analysis. Mode-shapes are normalized so that the roof component of ϕ_n equals unity (ϕ_{rn}=1).

b) Compute $s_n^* = m\phi_n$ (Chopra and Goel, 2004), where s_n^* shows the distribution of incremental lateral forces over the height of the structure for the n^th mode.

c) Compute the total target displacement of the structure at the roof, δ_t.

d) The CMP procedure consists of single-stage and multi-stage pushover analysis. First, Gravity analysis should be implemented and then, pushover analyses are performed according to the following sub-steps

   i. Perform the single-stage pushover analysis with the triangular load pattern for low to mid-rise building and the uniform load pattern for high-rise building until the control node at the roof of the building reaches the predetermined target displacement.

   ii. Perform two-stage pushover analysis for those buildings which their fundamental periods are less than 2.2s. In the first stage, a pushover analysis is performed by using the incremental lateral forces, $s_1^* = m\phi_1$, until the control node reaches $u_{r1} = \beta_1\delta_t$, (Eqn. 2.1, for i=1). Then, second stage should be performed. In this stage, a pushover analysis is implemented by using the incremental lateral forces, $s_2^* = m\phi_2$, until the control node reaches $u_{r2} = \beta_2\delta_t$, (Eqn. 2.3, for N_s=2 and i=2).

   iii. Perform three-stage pushover analysis for those buildings which have fundamental period more than 2.2s. The first stage are exactly is the same with the first stage of the two-stage pushover analysis. Next pushover analysis is performed by using, $s_2^* = m\phi_2$, until the control node reaches $u_{r2} = \beta_2\delta_t$ (Eqn. 2.1, for i=2). Then, last pushover analysis is implemented by using $s_3^* = m\phi_3$ until the control node reaches $u_{r3} = \beta_3\delta_t$, (Eqn. 2.3, for N_s=3 and i=3).

e) Calculate peak responses of desired values in each pushover analysis. In the paper the one-, two-and three-stage pushover response are denoted by r_1, r_2 and r_3 respectively.

f) Calculate the ultimate responses as follows:

$$r = Max\{r_1, r_2\} \quad , for T < 2.2s \qquad (2.4)$$

$$r = Max\{r_1, r_2, r_3\} \quad , for T \geq 2.2s \qquad (2.5)$$

III. Analytical Models, Assumptions and Types of Analysis

Four ten-story reinforced concrete building with 0%, 5%, 10% and 20% eccentricity in Y direction are considered as models as shown in Fig. 3.1. Lateral load resisting systems of buildings are concrete moment resistant frame with medium ductility. All frames consist of 4*5m bays in each direction and a story height of 3.0m is assumed. Some brief characteristics of buildings are listed in Table 3.

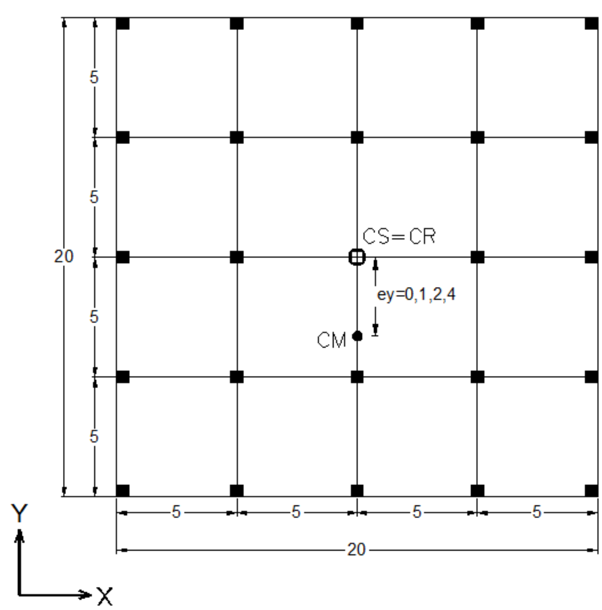

Figure 3.1 : Typical Plan of buildings considered (units in meters)

Table 3.1 : Models Characterististics

No.	No. of story	h(m)	b(m)	Eccentricity (%)	Periods (s)		
					T_1	T_2	T_3
S1	10	30	20	0%	1.23	1.23	0.99
S2				5%	1.25	1.23	0.98
S3				10%	1.29	1.23	0.97
S4				20%	1.45	1.25	0.94

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The OpenSEES program is used to create and analyze models. The DD+50%LL load combination are assumed in gravity analysis where DD, is the dead load and LL, is the live load. The CMP procedure is carried out for models. The P-Δ effects are neglected in all pushover analyses. Two modes are considered in the CMP procedure to develop responses and pushover analyses are implemented in X direction only. Each mode-shapes consists of two transitional (X,Y) and a rotational (rotation about Z) components. Since, models have eccentricities in Y direction as shown in Fig. 3.1., only X and rotational component of each mode-shape is considered and mode-shapes are normalized to 1 at top in X component. The target displacements are obtained as the maximum top floor displacement computed by NL-RHA. Seven far field ground motion records are selected from the ground motion database of the Pacific Earthquake Engineering Research Center (PEER) to run NL-RHA. A minimum 15 km distance from the station to surface rupture is considered to select record and soil type is B according to USGS classification system. All records are normalized to 0.35g before processing. Some detail characteristics of ground motion are listed in Table 3.2. The Dist. values stands for closest distance to surface projection of rupture in the table. The responses obtained from pushover analyses are compared with the mean of maximum responses computed by NL-RHA.

Table 3.2 : Characteristics of Ground Motions

No.	Name	Year	M	Recording Station	Dist.[1] (km)	Component	PGA(g)	PGV(cm/s)
1	Chichi	1999	7.6	TCU047	33.01	N	0.413	40.2
2	Imperial	1979	6.5	6604 Cerro Prieto	23.5	H-CPE147	0.169	11.6
3	Kocaali	1999	7.4	Arcelik	17	ARC000	0.218	17.7
4	Landers	1992	7.3	23 Coolwater	22.8	CLW-LN	0.283	25.6
5	Loma Prieta	1989	6.9	Anderson Dam	20	AND270	0.224	20.3
6	Northridge	1994	6.7	24000 LA	35.9	OBR090	0.335	16.7
7	Sanfernando	1971	6.6	24278 Castaic	24.2	OPR021	0.324	15.6

IV. Discussion of Results

The drift ratio is defined as the ratio between relative displacements of two story divided by height of the story and calculated as follows:

$$DR = \frac{d_{i+1} - d_i}{H} \quad (4.1)$$

Where, d_i, d_{1+1} and H are the displacement of the i^{th}, $(i+1)^{th}$ story and the height of the story respectively.

Story drift ratios are computed by the CMP, Triangular load pattern and NL-RHA and shown in Fig. 4.1 to 4.4. Figures illustrate that the CMP procedures estimate drift ratios for 10 story buildings well in comparison with NL-RHA results. As seen in Fig 4.1. to 4.4., the height-wise distribution of story drifts derived from the CMP is similar to NL-RHA. Additionally, the pushover analysis by using triangular lateral load pattern, underestimates drift ratios in higher levels in comparison with NL-RHA results.

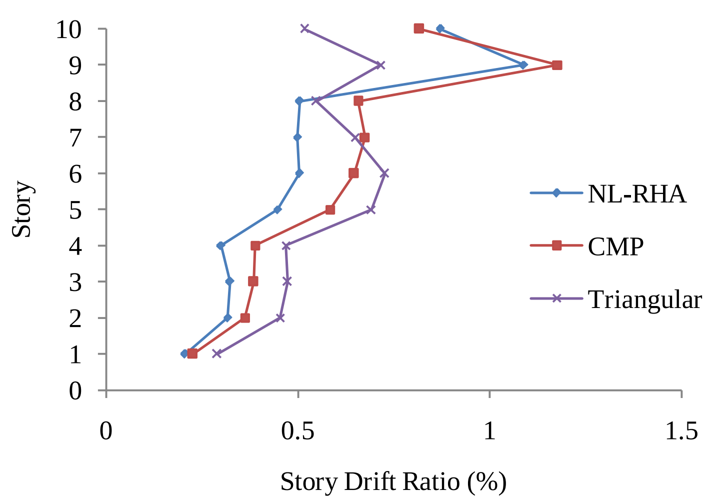

Figure 4.1 : Height-wise distribution of drift ratio for symmetric model

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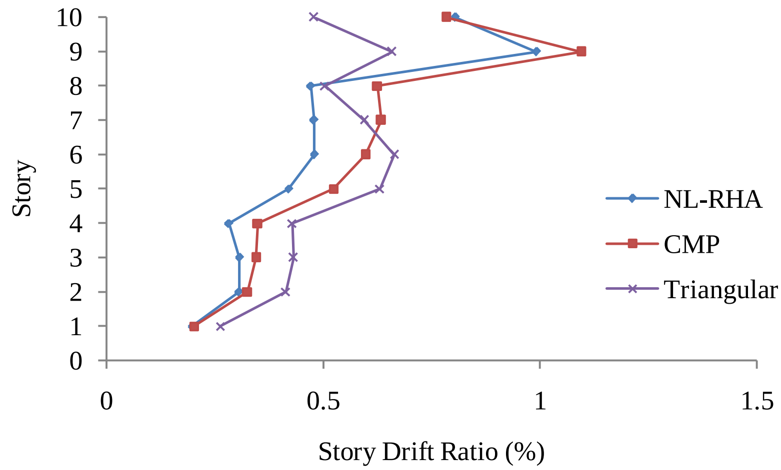

Figure 4.2 : Height-wise distribution of drift ratio for asymmetric model with 5% eccentricity

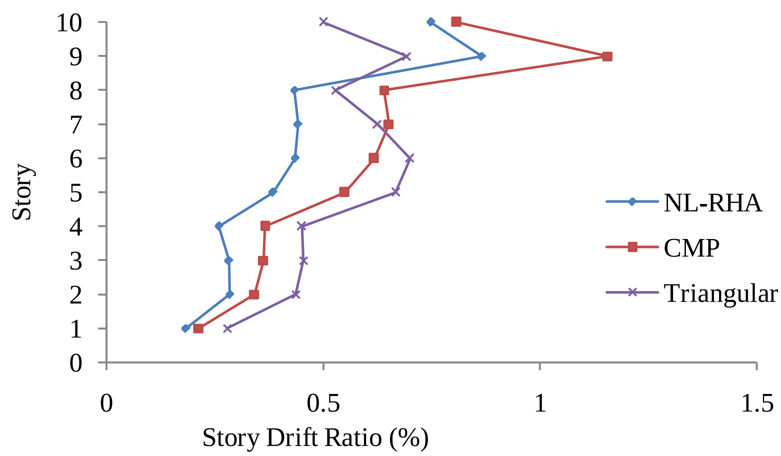

Figure 4.2 : Height-wise distribution of drift ratio for asymmetric model with 10% eccentricity

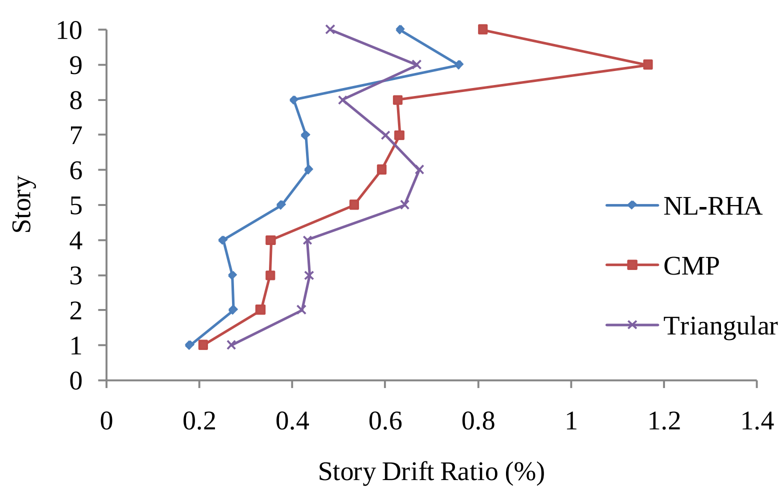

Figure 4.4 : Height-wise distribution of drift ratio for asymmetric model with 20% eccentricity

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V. Conclusion

Since higher-modes play significant role in tall building, The Consecutive Modal Pushover (CMP) procedure is proposed to consider higher-mode effects in the pushover analysis. It is assumed that dynamic characteristic of a structure are invariable during analysis and so, they are obtained through linearly-elastic analysis. The CMP procedure employs force distribution load pattern and consists of single-stage and multi-stage pushover analysis. The single–stage pushover analysis can be performed either by triangular or uniform load pattern. The multi-stage pushover analysis can be performed in two or three stages based on the height of the structure. Both single-stage and multi-stage pushover analysis are considered to develop results. The CMP procedure benefits from consecutive implementation of modal pushover analysis and uses limited number of modes to develop results. The CMP procedure estimates the height-wise distribution of drift ratio well, and their results are similar to results obtained by NL-RHA.

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A Remote Sensing and GIS based Approach for Vulnerability, Exposer and Landscape Trajectories in Olomouc, Czech Republic

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Keywords: remote sensing, gis, tourism, land cover classification, landsat etm+/tm, land use/cover, change trajectories, image classification, vulnerability index, exposer index, sensitivity index, adaptive capacity index, spatial principal component analysis (spca), environment vulnerability introduction.

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A Remote Sensing and GIS based Approach for Vulnerability, Exposer and Landscape Trajectories in Olomouc, Czech Republic

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Abstract- Olomouc with Jeseníky mountains tourism in Czech Republic is unique for its floristic richness, which is caused mainly by the altitude division and polymorphism of the landscape; climate and oil structure are other important factors. This study assesses the impacts of tourism on the land cover in the Jeseniky mountain region by comparing multi-temporal Landsat imagery (1991, 2001 and 2013) to describe the rate and extent of land-cover change throughout the Jeseniky mountain region. This was achieved through spectral classification of different land cover and by assessing the change in forest; settlements; pasture and agriculture in relation to increasing distances (5, 10 and 15 km) from three tourism site. The results indicate that the area was deforested (11.13%) from 1991 to 2001 than experienced forest regrowth (6.71%) from 2001 to 2013. In first decay pasture and agriculture areas was increase and then in next decay it was decrease. The influence of tourism facilities on land cover is also variable. Around each of the tourism site sampled there was a general trend of forest removal decreasing as the distance from each village increased, which indicates tourism does have a negative impact on forests. However, there was an opposite trend from 2001 to 2013 that indicate conservation area. The interplay among global (tourism, climate), regional (national policies, large-river management), and local (construction and agriculture, energy and water sources to support the tourism industry) factors drives a distinctive but complex pattern of land-use and land-cover disturbance.

As Olomouc is a unique and complex landmark with widespread forestation and land use. This research work was conducted to assess important and complex land use change trajectories in Olomouc region. Multi-temporal satellite data from 1991, 2001 and 2013 were used to extract land use/cover types by object oriented classification method. To achieve the objectives, three different aspects were used, that is: (1) Calculate the quantity of each transition; (2) Allocate location based landscape pattern (3) Compare land use/cover evaluation procedure. Land cover change trajectories show that 16.69% agriculture, 54.33% forest and 21.98% other areas (settlement, pasture and water-body) were stable in all three decade. Approximately 30% of the study area maintained as a same land cove type from 1991 to 2013. Here broad scale of political and socio-economic factors also affects the rate and direction of landscape changes. Distance from the settlements was the most important predictor of land cover change trajectories. This showed that most of landscape trajectories were caused by socio-economic activities and mainly led to virtuous change on the ecological environments.

This research work also focus on vulnerability and exposer intensity due to land use change in Olomouc, Czech Republic. Assessment of vulnerability with exposer intensity to land use change is an important step for enhancing the understanding and decision-making to reduce vulnerability. This research work includes quantification of Exposure Index (EI), Sensitivity Index (SI) and Adaptive Capacity Index (AI). EI is based on intensity of land use change, SI and AI based on natural factors such as elevation, slope, vegetation and land cover. Vulnerability Index (VI) derived on the quantification of SI and AI and compared among three decades from 1991, 2001 and 2013. Comparing of EI and VI for last three decades, water have lowest vulnerability index and settlements have highest vulnerability index due to high socio-economic activities. Agriculture has highest exposer index and second highest vulnerability, which show its high rate of exploitation and production. In the study areas, vulnerability tends to increase with the increase of exposure to land use change, but can peak off once the land use start to benefit socio-economically from development. Only in this way we can enhance the adaptive capacity of study area to use change of land.

In the research work remote sensing (RS) and geographical information system (GIS) technology were used to develop an environmental numerical model for vulnerability evaluation based on spatial principle component analysis (SPCA) method. Based on environmental numerical modal an environmental vulnerability index (EVI) for the year of 1991, 2001 and 2013 of the study area were calculated. This numerical model has five thematic layers including height, slope, aspect, vegetation and land use/cover maps. The whole area vulnerability is classified into four classes: slight, light, medial and heavy level based on cluster principle. Results show that environmental vulnerability integrated index (EVSI) was continuously decreased from 2.11 to 2.01 from the year 1991 to 2013. The distribution of environmental vulnerability is vertical and present heavy in low elevation and slight in high elevation. The overall vulnerability of the study area is light level and the main driving forces are socio-economic activities and human interferences.

Keywords: remote sensing, gis, tourism, land cover classification, landsat etm+/tm, land use/cover, change trajectories, image classification, vulnerability index, exposer index, sensitivity index, adaptive capacity index, spatial principal component analysis (spca), environment vulnerability introduction.

I. Introduction

The Olomouc Region has a rich diversity of activities capable of pleasing even the most demanding visitors. This is a place for enthusiasts

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of historical and natural monuments, winter sports, and bicycle tours. The Jeseníky Mountains offer a paradise full of natural treasures and hundreds of well-marked routes for hikers and cyclists, along with countless educational trails, caves, waterfalls and viewing towers. The natural centre of the Olomouc region is the city of Olomouc with its distinguished monument, the Holy Trinity Column, which is inscribed on the UNESCO World Heritage List [1]. Its area is 5,267 km^2 (January 1, 2006), 6.7 % of the national territory, making it the 8th largest region in the country. As of H1 2009 there are 642,080 inhabitants (6.1 % of the population of the Czech Republic, the 6th most populated region in the country). Its 397 communities make up for 6.4 % of all communities in the country [2]. Olomouc, the regional capital with a population of 100,168 is the 5th largest city in the Czech Republic. There are 13 towns and cities with populations exceeding 5,000 in the region [3] and most attractive place for tourism [4].

The early 1990s produced a boom in tourism for Czech Republic, as the country of architecture and rich culture were 'rediscovered' by Western Europeans curious to visit a country formerly hidden behind the Iron Curtain and the tourism boom brought US$ 4 billion per annum to the state budget [1] with almost no marketing and promotion. Prior to the collapse of communism, the service sector (and hence the tourism industry) in the Czech Republic was weakly developed [5, 6]. The universal right to work, common to all ex-communist countries, favored employment in heavy industries and/or collective agriculture. Neither, private ownership of enterprises nor NGO activity was permitted [7]. As in the rest of Eastern Europe, since the fall of the Iron Curtain in 1990 the economy underwent rapid transition, most notably the collapse of the primary sector and consequently rising unemployment. Between 1980 and 2000, the contribution of secondary industries to the GDP fell from 63% to 43%, while the contribution of tertiary industries increased from 30% to 53% [8].

Last five decades agriculture and forested landscapes have been transformed by economic and social development [9, 10]. These transformations are important components of land cover disturbance and global environmental change [11, 12]. The most rapid and significant include deforestation as a consequence of urbanization, agricultural expansion, logging, and pastoral expansion [13]. A theoretical framework to explain the nature of resource use by the tourism industry is the Von Thunen model [14]. Von Thunen's theory suggests that resource extraction decreases with increasing distance from settlements due to the costs of transport [15]. This premise has been outdated for industrialized parts of the world due to improved infrastructure [16].

Land cover disturbance and environmental impact of tourism is particularly critical in mountain regions [17]. Mountain communities are typically less affluent than their counterparts in lowland regions, and poverty is still a fact in many mountainous areas [18]. Infrastructure development is hampered by difficult access and harsh climate [19]. The drawing of policies and plans is less effective in mountain areas, because historically these areas have been of marginal concern for decision-makers, and therefore neglected in development priorities [20]. Moreover, policy implementation is undermined by political instability, which often characterizes mountain areas due to their proximity to national and international borders [21]. On top of these factors, there are peculiar conditions of mountain areas that make them more vulnerable, such as land cover disturbance, environmental fragility and tourism seasonality. High-altitude ecosystems are inherently fragile and characterized by low resiliency, and therefore they are particularly susceptible to human interference, such as soil and vegetation trampling, disturbance to native wildlife, and waste dumping [22, 23]. High altitude recreation sites are characterized by extreme seasonality, because accessibility and favorable climatic conditions are restricted to the short summer season. Consequently, human-induced disturbances on the land cover and environment are concentrated in this period that is also the peak season for several biological processes, such as mating, vegetation growth, migration, spawning, etc [24].

Socio-economic activities have been one of the most important factors for land cover change trajectories. In place of two dates of change in satellite imageries, researchers are more focus on temporal land cover change trajectories [25]. In European Union (EU) 43% land is farmland and 26% arable. For Czech Republic it`s 54% and 37% respectively [26]. Only 17% of farmland is farmed by the landowners and this is the second lowest in EU [26]. These growing environmental problems in recent decades frequently ensue from two dominant trends in the current use of agricultural land within Europe [27]: intensification and specialization in some areas accompanied by marginalization and abandonment in others. Earlier land cover change in Czech Republic have analyzed by many authors. These studies focused on the influence of extreme fragmentation of agricultural land ownership as an important driver of homogenization of rural landscape patterns were presented by [28] and [29]. Historical maps reaching back to the mid-18th century were used by [30] to analyses long-term land-cover changes in 21 cadastral units of Central Bohemia. They mention that 18% to 5% permanent grassland and 6% to less than 1% surface water area were decrease.

Trajectory analysis is a new method for land cover change research based on each pixel`s in time series. [31] developed a trajectory-based hierarchical decision tree to delineate warm season grass (WSG) and cool season grass (CSG) for long term WSG/CSG mapping. Temporal trajectory is using to discover land

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use/cover change trends by constructing the 'curves' or 'profiles' of multi-temporal data [32]. The concept of trajectory to change has attracted some attention from a theoretical viewpoint [33]. These trajectories defined as trends over time among the relationships between the factors. These factors shape the changing nature of human–environment relation and their effects within a particular region [34]. This takes widely different forms and depends on circumstances, regional contexts, and government policies. These studies have further highlighted the importance of understanding landscape dynamics for sustainability and conservation purposes [35].

Remote sensing data are particularly useful due to the cost and time associated with traditional survey methods [36, 37]. These techniques have become viable alternatives to conventional survey and ground-based mapping methods [38]. Remote sensing and geographic Information Systems are powerful and effective tools for assessing the spatial and temporal dynamics of landscape trajectories [39]. Remote sensing data provide valuable multi-temporal information of the processes and patterns of land cover change. GIS is useful for mapping and analyzing these patterns [40]. In addition, retrospective and consistent synoptic coverage from satellites is particularly useful in areas where changes have been rapid [41]. Furthermore, since digital archives of remotely sensed data provide the opportunity to study historical land use/cover changes, the geographic pattern of such changes in relation to other environmental and human factors can be evaluated. In addition, accurate and comprehensive land cover change trajectories statistics are useful for devising sustainable development and planning strategies [42]. It is therefore very important to estimate the rate, pattern and type of land cover change trajectories in order to predict future changes for sustainable development.

This research present land cover change trajectories analysis for forest, agriculture and others (settlement, pasture and water body) for three decades (1991, 2001 and 2013) in the Olomouc, Czech Republic. This research seeks to: (1) Capture the spatio-temporal variability of landscape change trajectories in Olomouc, (2) Comparing RS, GIS and socio-economic factors in Olomouc. Pre- and post-classification comparison techniques have been extensively used [43]. In the pre-classification approach procedure such as image differencing [44], band rationing [45], change vector analysis [46], direct multi-date classification [47], vegetation index differencing [48] and principle component analysis [49] have been developed [50]. These techniques are useful for locating the change but they are unable to identify nature of change [51].

In Olomouc, Czech Republic highly productive regions with high density of population are most exploited areas. These areas are experiencing various environmental impacts and climate change associated with local, regional and global issues. These areas are highly vulnerable to threats from both natural processes and socio-economic activities [52]. Present research on vulnerability is focus on natural disasters and climate related impacts such as droughts, floods, see level rise and cyclones [53], but not on non-climatic parameters such as elevation, slope, aspects, vegetation and socio-economic activities [54]. Maximum vulnerability studies are on national and continental level but at small level, local factors along with socio-economic activities such as land use change and pollution, might have more profound impacts than global climate change.

In this research work we used three terms (exposure, sensitivity and adaptive capacity) inside the vulnerability. While there is considerable heterogeneity in both the potential impacts of environmental changes, and the adaptive capacity to cope with these impacts, this assessment shows that study area in particular will be vulnerable to natural parameters, ecosystem and land use change [55]. Projected economic growth increases adaptive capacity, but is also associated with the most negative potential impacts. The potential impacts of more environmentally oriented developments are smaller, indicating an important role for both policy and society in determining eventual residual impacts [56].

Economic growth directly effect on land use change because a large part of forest and agriculture area convert in urbanization and industrial areas. Recent studies shows, that there is a positive feedback between landscape urbanization and economic growth in Czech Republic [57], indicating the existence of a strong driver for land use conversion from forest and agriculture to urban use [58]. This conversion some time cause of excessive exploitation of natural resources and their regional imbalance. These changes are main cause of different types of vulnerability and their transfer from one to other type of vulnerability. As the objective of this research is to develop a module with an indicator system to compare vulnerability due to exposed of land use change, using the concepts of exposure, sensitivity and adaptive capacity [59]). The results are showing relationship between vulnerability, exposure and land use change. In last we compare results for last three decades for 1991, 2001 and 2013.

Environmental vulnerability evaluation is characterizing the vulnerability and resilience of socio-ecological systems exposed to environmental hazards. Previous research developed many methods such as fuzzy evaluation method [60], the gray evaluation method [61] along with the artificial neural-network evaluation method [62], and the landscape evaluation method [63]. These methods are based on quantitative analysis and their variables are not easy to acquired or operated in the model. However, advancement in remote sensing, GIS and numerical modelling

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techniques is a powerful tool for environmental vulnerability assessment [64].

Since last three decades in Olomouc from 1991 to 2013, land cover has transformed dramatically due to socio-economic activities and extraction of natural resources [65]. Unlimited or unwanted exploitation of natural resources reduces their sustainability limit and this has become a cause of serious concern for the government and the people of Czech Republic. Recently land use/cover studies have attracted wide variety of researcher, ranging from those who are modelling the spatial and temporal patterns of land conversion, to those who try to understand the causes and consequences of land use changes [66, 67].

Remote sensing, GIS and numerical modelling techniques played a great role in extraction and preparation of the environmental vulnerability evaluation attributes [68]. The major objective of this study is to evaluate the environmental vulnerability in a typical mountainous region characterized by apparent vertical-belt features. Both natural and human induced attributes were considered [69]. The land use and vegetation cover maps were derived from landsat TM and ETM+ data with a resolution of 25-30m through classification and interpretation of the land cover features [70]. Terrain characteristics namely slope; elevation and aspects were derived from Digital Elevation Model (DEM). The specific objectives of this study were to (i) measure the quality and quantity of LUCC; (ii) evaluate the vulnerability of environment during three intermediary periods from 1991 to 2013; (iii) elucidate changing trends of vulnerability in terms of location, intensity and the nature of the threats; (iv) an environmental numerical evaluation model was set up supported by GIS; (v) the spatial principal component analysis (SPCA) was developed to build an environmental vulnerability index (EVI) model and the computed result is classified using the cluster principle; (vi) the spatial distribution and its change of environmental vulnerability were analysed and driving forcing for change are discussed. (vii) the regionalization is worked out as the basis for environmental rebuilding planning [80].

II. Materials and Methods

a) *Study Area*

The study area cover Olomouc Region, which is located in north-eastern Czech Republic between 49°45´ N, and 17°15´ E (Fig. 1). The border between the Olomouc region and Poland in the north is 104 km long. The other neighbours are the Moravskoslezský Region in the east, the Zlín Region and the Jihomoravský Region in the south and the Pardubický Region in the west. The geographical layout of the region is rather unusual. There are lowlands at the Polish borders, followed by the Jeseníky mountain range with Praded (map) as highest mountain (1.492 m above sea level), while the southern part (again) comprises lowlands – the flat and fertile land of Haná. This region is one of the most fertile areas of the Czech Republic. Its elevation is 219 m (719 ft) and total area is 103.36 km^2. Its total population is 101,003 with 987/km^2 density.

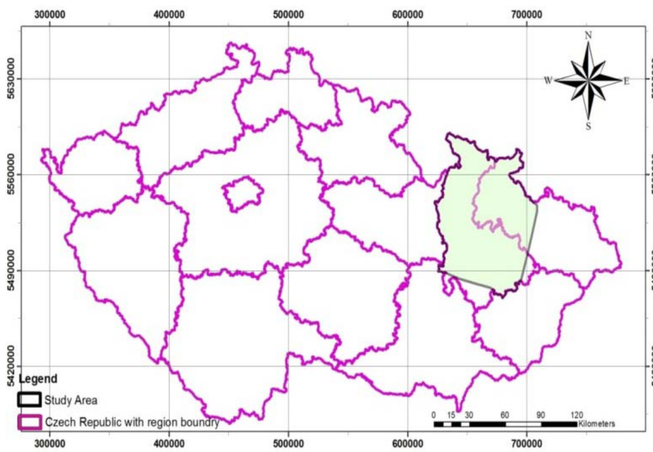

Fig. 1 : Study area: Jeseniky mountain region, Olomouc

This region is characterised by coniferous forest (Pinus sylvestris L.and Picea abies L. Karst.) and large aapa mires. Deciduous trees mainly Betula spp. occur to a lesser extent and located in the northern boreal vegetation zone. Highest fells and alpine vegetation are found in the north-western part of the study region in the Jeseniky mountain area. A large number of lichen pastures with forest are located in the eastern and north-eastern mountainous part of the Olomouc region. The most important late winter pastures with arboreal lichens are located in the western, central and southern parts of the Olomouc Region [81]. Summer and autumn pasture with vegetation are consisting in mires, lake and riversides. Moist forest and fresh forest are present in the north-eastern, south-western, eastern and western parts of the Olomouc Region [82].

b) *Data*

NASA Landsate TM and ETM+ data (1991, 2001 & 2013) were used for vulnerability evolution. ArcGIS 10.1 software was used for all image preparation, spatial analysis and mapping. The data of land use and vegetation is derived from landsat data by user-computer interactive interpreting method. Elevation and slope maps were generated from DEM. Topographic database provides the most accurate and uniform information for map products, which covering the entire country, so geographic corrections were performed on the base of topographic sheets and then registered (UTM WGS84) all images. 26 ground control points (GCPs) were used for registration. All GCPs were dispersed throughout the scene, yielding a RMS error of less than 0.5 pixels. The photographs were acquired with a frame camera that was designed to support mapping, charting and geodesy in addition to two high-resolution cameras. The ground-truth data required for

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visual interpretation and accuracy assessment of IRS images was collected from the field in April, 2014. Socio-economic information and natural resource use pattern of the local communities was generated using questionnaire method.

One Landsat 5 TM and two Landsat 7 ETM+ images (WRS II Path 190, Row 25; 9 Oct. 1991, 14 April 2001, 24 September 2013) were used for this research. Which were selected for their clarity and being at least 10 years apart. ArcGIS 10.1 software was used for all image preparation, spatial analysis and mapping. Topographic maps served as the base maps and was rectified (UTM WGS84) to the roads layer with a nearest-neighbour resampling (RMSE< 0.5 pixels, or <15 m). Image-to-image registration was performed on the other images. After completing the registration, each image was radiometrically calibrated to correct for sensor related, illumination, and atmospheric sources of variance (Green et al., 2005). The ancillary data used in this research includes:

- Photos and field notes recorded in 2013 during a trek around the study area
- Google Earth images used as reference data during the classification and validation phases of the analysis
- GIS layers of the study area, which includes roads, rivers, ecology and boundaries, and a land-cover map obtained from the European Space Agency (ESA) and the United States Geological Survey.

c) Field Data Collection

Field work was conducted to determine ambiguous land-cover classification and to visit area of major change to determine causes of the changes with both observation and informal interviews of local people. This also provided a secondary validation of the classification accuracy for the most current image date. A *Trimble* hand-held GPS with an accuracy of 10 meters was used to map and collect the coordinates of important land use features during pre- and post-classification field visits to the study area in order to prepare land-use and land-cover maps.

d) Normalized difference Vegeatation Index (NDVI) calculation and change detection

The Normalized Difference Vegetation Index (NDVI) is calculated as (NIR - red) / (NIR + red), where red corresponds to Landsat TM band 3 and near-infrared to band 4. Continuous NDVI values range from -1 to +1. High values closer to +1 are associated with healthy green vegetation and standing biomass. NDVI was calculated for each image date and using these images we then calculated standard normal deviates (Z-scores) to minimize the influence of seasonal variation and inter-annual differences [83]. The use of the standard normal deviates reduces much of the potential effect of inter-annual climate variation, which is necessary even when using anniversary dates and calibrated imagery, in a region influenced so heavily by rainy season precipitation amounts.

e) Image Classification

In this research work, first was used unsupervised classification and after field visit and identification of land cove classes, supervised classification was used on the basis of training sites. Forest was defined as >30% tree canopy closure to separate the dense forest area from scrub and agriculture lands. Non forested land includes an aggregation of the other land covers water, pasture (which at this time of year includes agriculture, which presents as bare soil, within this cover), built, and scrub. The DEM was used to separate the high and low elevation area.

Three tourist sites (Olomouc, Rymarov and Jesenilk) were identified to access tourism effect, using the field notes as a guide and spatially located as a point GIS layer. A gradient of tourism proximity was generated using the ArcGIS "multi-ring buffer" tool to produce three concentric circles placed 5 km apart around each of the tourism facilities. Then proximity zone were overlaid on land cover change layer, and statistics for each tourism facility and proximity zone. This was further analysed to calculate the net percentage change in forest, agriculture, pasture, settlements and regression analysis was used to identify trends in change and tourism proximity. This analysis was applied for all three tourism facilities combined, the Olomouc, Rymarov and Jeseniky facilities for 1991, 2001 and 2013 (Fig. 2).

f) Land use/cover analysis

After pre-processing and geometric correction, all satellite images used for classification to know changes in between two dates in the study area. A number of methods are available for temporal land use change detection, including: (i) post-classification comparison, (ii) classification of multi-temporal data sets, (iii) principal components analysis (PCA), (iv) temporal image differencing and rationing, (v) change vector analysis and (vi) spectral mixture analysis. The main emphasis of the study was on change in natural forest cover (i.e. deforestation) and areas under intensive cultivation. In satellite image classification, vegetated area was comprised mixture of surface materials such as different canopy components, bare soil, water and shadow. The spectrum measured by the sensor was therefore a mixture of each of these components [84].

This research work report the finding of post-classification comparison between two dates images in the study area. First unsupervised classification and then supervised maximum likelihood classification (MLC) were used to obtain the best results from remotely sensed data. Gaussian distribution [85] was

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applied in each image. In supervised classification training sites were based on reference data and ancillary information. In last, post-classification refinement was used to improve the accuracy of classification. Three major land cover classes were identified: forest, agriculture and others (water body, pasture and settlements). In this research work three land cover classes for three time nodes were used in the trajectory analysis to monitor land use/cover change dynamics.

We used simple metrics for quantifying the landscape structure and their behavior predicated across all evaluation [86]. In ArcGIS, an iterative multi-objective land allocation procedure was used to resolve conflicts decision heuristic and carried out change trajectories over the landscape. The definition of forest cover was minimum 30% canopy coverage which provides a distinct delineation between scrub areas and dene forest. Follow-up field work was conducted in October 20013 and February 2014, to determine ambiguous land-cover classification. Visit study area to determine major changes and there causes by observations and informal interviews of local people. This also provided a secondary validation of the classification accuracy for the most current image date.

The terrain complexity complicates the interpretation of spectral signatures in land use/cover mapping and changes. Which were influenced by elevation, aspect, and slope; this could lead to similar objects showing different reflectance and/or the different objects presenting the same reflectance, especially in dark shadow areas [87]. So in visual image interpretation techniques, it's used a combination of subjective and objective methods. Ground truth information was used in doubtful areas during image interpretation. The hydrological DEM was generated from contour and drainage layers in ArcInfo using topogrid tool. Slope and aspects were derived from the DEM and then changes were studied along all the topographic parameters using matrix functions [88].

Table 1 : Land cover areas (km^2) changes for 1991, 2001 and 2013

	1991		2001		2013		1991-2001		2001-2013		1991-2013	
Class	Area	%	Area	%	Area	%	Area Diff.	% Diff.	Area Diff.	% Diff.	Area Diff.	% Diff.
Water	209.85	10.49	243.77	12.19	298.85	14.94	33.92	1.70	55.08	2.75	89.00	4.45
Forest	804.02	40.20	581.49	29.07	715.61	35.78	-222.53	-11.13	134.12	6.71	-88.42	-4.42
Settlement	29.87	1.49	26.42	1.32	43.55	2.18	-3.45	-0.17	17.13	0.86	13.68	0.69
Pasture	213.03	10.65	301.75	15.09	160.09	8.00	88.72	4.44	-141.66	-7.08	-52.94	-2.64
Agriculture	743.23	37.16	846.57	42.33	781.90	39.09	103.34	5.17	-64.67	-3.23	38.67	1.93
Total	2000.00	100.00	2000.00	100.00	2000.00	100.00	Land use/cover changes					

Agriculture and forested land makes up the largest percent of the study area with 35%, 40%, area in 1991 and vice versa in 2013 (Table 1). Forest makes up the largest land-cover, and occurs predominantly in the more upland areas with greater relief (Fig. 2). Forest area was decrease (222.53 km^2) slightly during the first half of the study period but then increase (35.78 km^2) during the second half of the study. Water makes up less than 15% of the upland landscape for all years of the study. Table 1 provides the areas of each class. The total area of the study was 2000 km^2. From 1991 to 2001, there has been a net decrease of forest is 11.13%. But in 2001 to 2013, 6.71% forest area was added. Pasture and agriculture was added 4.44% and 5.17% respectively from 1991 to 2001 but both area reduce (7.08% and 3.23% respectively) from 2001 to 2013. From 1991 to 2013 forest and pasture area was reduces (4.42% and 2.64% respectively). Where agriculture and settlements increased 1.93% and 0.69% from 1991 to 2013, here total water body area was highest increased around 4.50% from 1991 to 2013 (Fig. 2). These changes show governmental protection of forest area in between 2001 to 2013. Table 1 show that no change in number of settlements from 1991 to 2001 but for next decay settlements and water body area was increased.

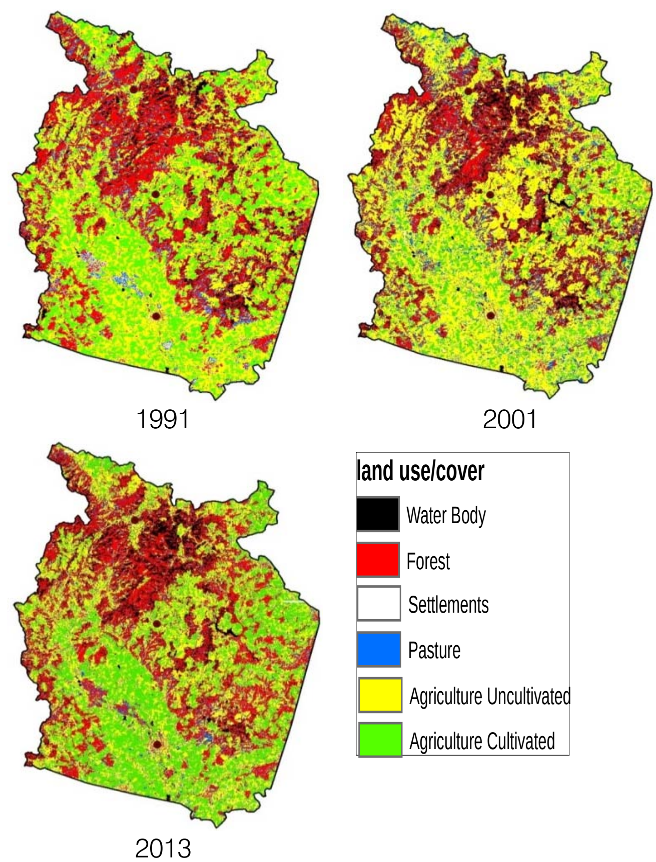

Fig. 2 : Land Cover change for 1991, 2001 and 2013

g) *Vulnerability concept*

The vulnerability is a function of the character, magnitude and rate of natural resources change and variation to which a system is exposed, its sensitivity, and its adaptive capacity. Landscape condition is determined the susceptibility of a community to the impact of hazards, the degree to which a system is susceptible to, or unable to cope with, adverse effects

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on natural resources, including variability and extremes. So we can say vulnerability is a function of exposure, sensitivity and adaptive capacity [89]. Where potential impacts are a function of exposure and sensitivity therefore, vulnerability is a function of potential impacts and adaptive capacity (Fig. 3).

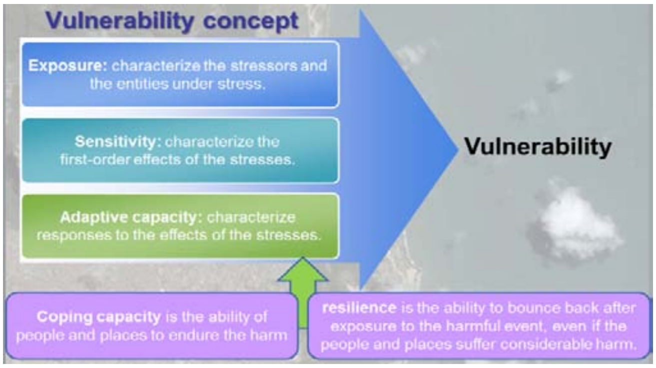

Fig. 3 : Vulnerability concept (Mukesh Singh Boori PhD thesis)

As vulnerability include the three dimensions: exposure, sensitivity, and adaptive capacity. Where exposure components characterize the stressors and the entities under stress, Sensitivity components characterize the first order effects of the stresses, and adaptive capacity components characterize responses to the effects of the stresses (fig. 3). These measures can be quantitative (e.g., precipitation variability, distance to market) or qualitative (e.g., political party affiliation, environmental preservation ethic). Another slightly different view favored by the hazards and disasters research community is that adaptive capacity consists of two subcomponents: coping capacity and resilience. Coping capacity is the ability of people and places to endure the harm, and resilience is the ability to bounce back after exposure to the harmful event, even if the people and places suffer considerable harm. In both cases, individuals and communities can take measures to increase their abilities to cope and bounce back; again depending on the physical, social, economic, spiritual, and other resources they have or have access to [90].

Another basic issue for the evaluation a model is to assign weights to each factor according to its relative effects of factors considered on the vulnerability in a thematic layer. The analytic hierarchy process, a theory dealing with complex technological, economical, and socio-political problems [91, 92], is an appropriate method for deriving the weight assigned to each factor. The degree of membership within different levels of different indices was integrated using weight and the total degree of membership for different thematic layers was used to calculate the whole study area vulnerability. The application of subjective weightings on the one hand gives us some indication of how the relative importance of different factors might vary with context, and can also tell us how sensitive vulnerability ratings are to perceptions of vulnerability in the expert community.

h) *Standardised the indicators*

This study is based on the quantification of sensitivity and adaptive capacity. Here various indicators are define and measure sensitivity and adaptive capacity such as elevation, slope, vegetation and land use. In this study, adaptive capacity is defined as the ability of the natural resources to adapt to a changing environment caused by land use change, which depends on natural factors. Land use change is a spatial manifestation of human activities, associated with regional planning, land management and economic development. High intensity of land use may present a potential threat to local ecosystem or community. Land use change may impact on geology, geomorphology, soil, vegetation, surface water body, quality of water and create disturbance in ecosystem and sometime cause of natural disasters [93]. All are important factors for sensitivity due to land use change. Sensitivity of an area was reflected in the following aspects: (1) the extent of natives' discontent with contaminated living environment. Along with the progress of land use change, natural vegetation around villages were destroyed, but population and industry increased a lot, making sewage and garbage beyond the purification capacity of ecosystem. So the natives would be dissatisfied and suffer psychological and economic losses. (2) The percentage of occupied farmlands with the expansion of industrial and residential areas. (3) The percentage of lack of fresh water resource by the reason of flow reduction and pollution. While flow reduction is the result of occupation of catchment areas and river ways by waterproof buildings, and pollution is the result of excessive industrial waste. Since aquiculture and agriculture both depended on fresh water, farmers have been severely affected. (4) The degree of unemployment. It is much serious in farmers because of farmland loss. (5) The rate of loss of traditional culture. In a changing environment, the traditional culture always fades away to exchange for economic opportunity, such as traditional architecture. Adaptive capacity is the ability of human sectors to handle change, which is determined by various factors such as economic development, technology and infrastructure, information, knowledge and skills [94].

It is important to note that each designated indicator system is inevitably subjective (Fig. 4). It presents only one possible result of vulnerability assessment. Therefore, it is more meaningful to use these indicators to compare relative values across study area as well as longitudinal comparison within the same area, rather than trying to make sense of the absolute values of indices. In view of different dimensions and magnitudes of the indicators, a standardization of the

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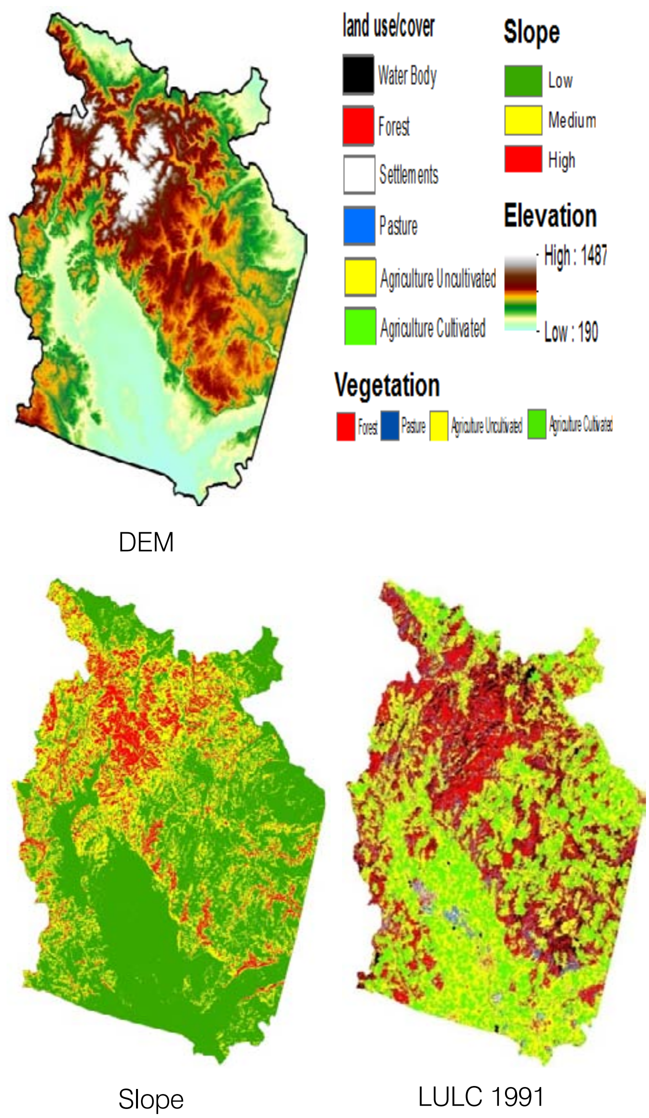
initial value is required. For indicators associated with the target index, make

$$y_{ij} = \frac{x_{ij}}{\sum_{i=1}^{m} x_{ij}} \; (i \mathcal{E}[1, m], j \mathcal{E}[1, n]) \qquad (1)$$

Where y_{ij} is the standardized value of indicator; x_{ij} is the initial value of indicator, i is the serial number of the study area, j is the serial number of the indicator, m is the number of study areas, n is the number of indicators (Fig. 4).



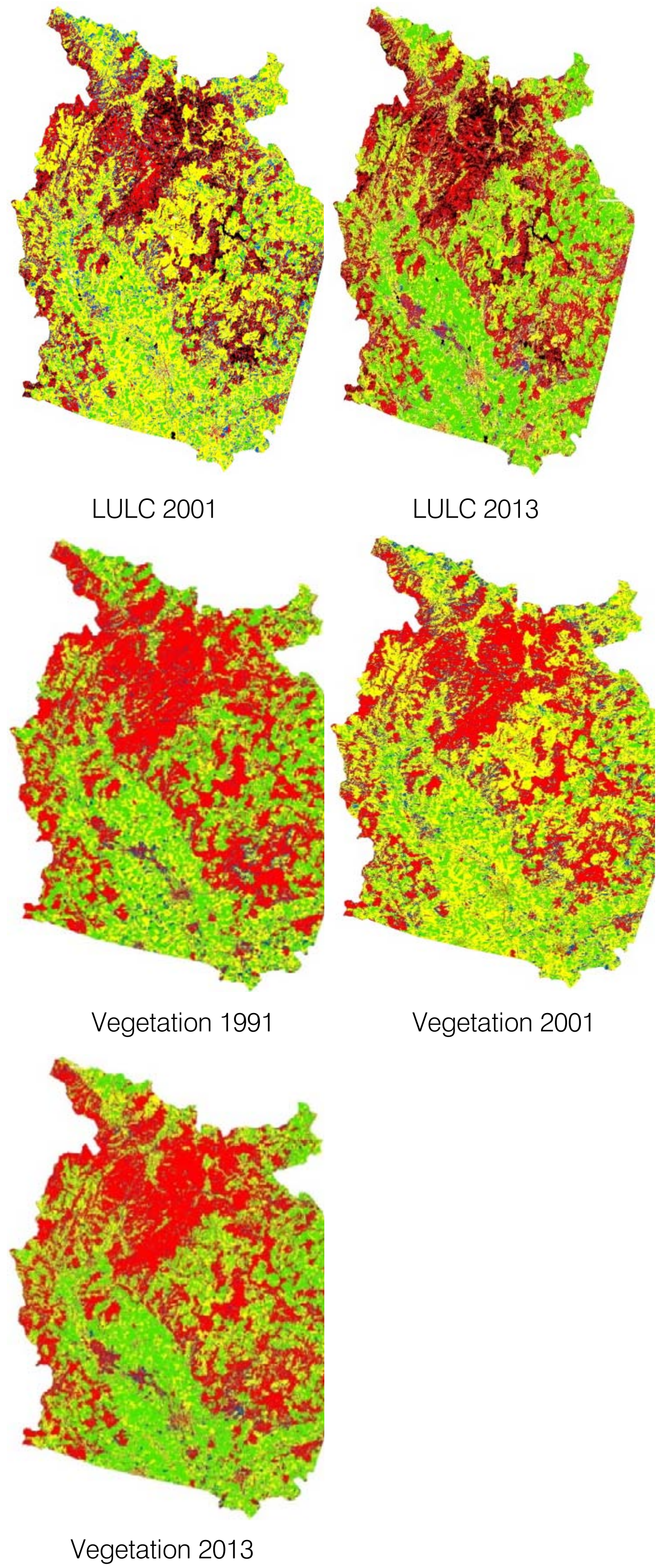


Fig. 4 : DEM, Slope, vegetation and land use/cover maps

After the standardization, SI and AI can be calculated based on Eq. (2), equal to the geometric mean of its standardized indicators. In this way the information of every indicator is contained by the target

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index, and each indicator is given the same weight, simple but clear. We choose the geometric mean algorithm because its result is eclectic and smoother than that of arithmetic mean, especially when some indicators of an object are unusually large or small.

$$SI_j \ or \ AI_j = \left(\prod_{i=1}^{n} y_{ij}\right)^{1/n} \quad (2)$$

We used equation 6 to generate Vulnerability Index (VI). VI is proportion to sensitivity index (SI) and adaptive capacity index (AI). SI indicates negative effect of land use change and AI show positive effects. Here exposure is not including in the equation, but there relationship is the core of this study.

$$VI = \frac{SI}{AI} \quad (3)$$

Where VI is Vulnerability Index, SI is Sensitivity Index, and AI is Adaptive Capacity Index. Vulnerability maps of the study area for 1991, 2001 and 2013 are shown in figure 5.

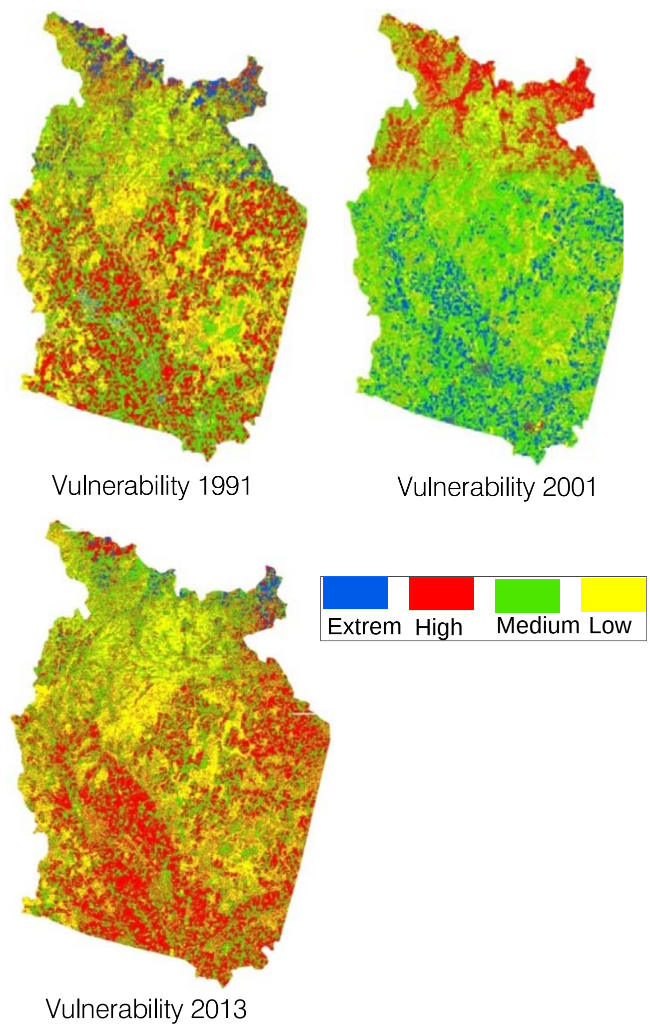


Fig. 5 : Vulnerability maps of the study area.

Figure 5 shows that extreme vulnerability was very less in 1991 but it was very high in 2001 due to degradation of forest and then 2013, its recover due to governmental protection. High vulnerability is present in areas, which is related to socio-economic activities. Low and medium vulnerability present in stable forest or low human impact areas.

i) Exposer intensity based on land use change

Since land use change was defined as the exposure of land classes in this study, we constructed Exposure Index (EI) based on land use intensity, which reflects the degree of human impact on natural land, containing information on patterns and their proportions of land use (Liu, 1996).

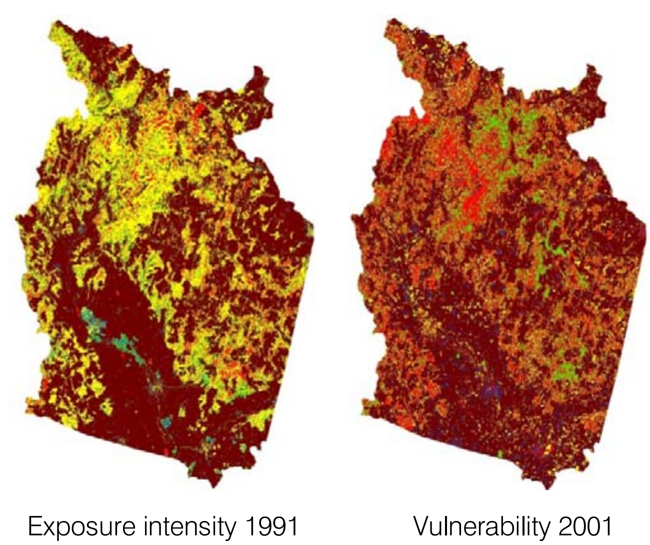
$$EI = \frac{i * c_i}{10} \quad (4)$$

Where EI is the Exposure Index, i is the rank of land use, Ci is the area percentage of land use of rank i. EI can be calculated according to Eq. (4) and Table 2. We make n = 4 in Table 2.

Table 2 : Correspond between types and ranks of land use

Types of land use	Rank (i)	Example
Limited used	1	Forest
Low impact used	2	Agriculture land
Medium impact used	3	Pasture and water body
High impact used	4	Settlements, tourism, industry, transport

Figure 6 show the exposer intensity of the study area. In all three decades exposer index is high in agriculture and socio-economic activities area, where human interaction is high. In protected forest area, exposer intensity is low due to less human interaction or less exploitation.



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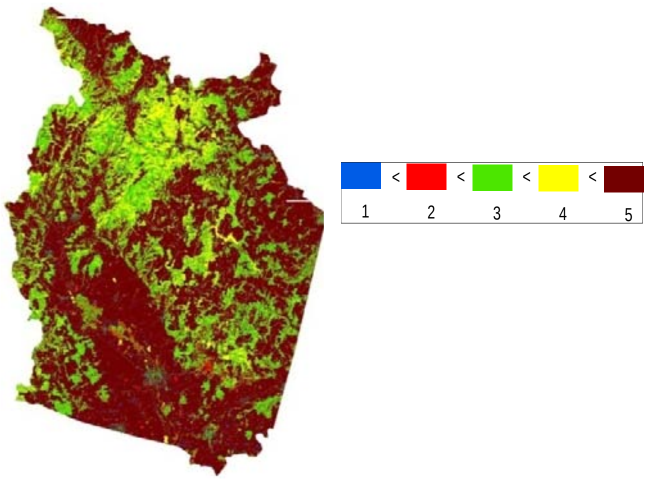

Vulnerability 2013

Fig. 6 : Exposer intensity maps of the study area

j) Evaluation principle and factors

For environmental vulnerability assessment, there is a need to determine the factors which pose negative impact on ecosystem and make sensitive the system. Following thematic layers were used for environmental vulnerability analysis: slope, aspects, height, vegetation and land use/cover maps. The whole vulnerability analysis work grouped in two parts first data preparation and second evaluation model. In first part: standardised maps were reclassified and recorded in raster maps. The principal component analysis (PCA) method, which using coefficients of linear correlation were used for the possibility weight of contributed factors [95, 96]. This study has developed an environmental vulnerability evaluation (EVE) model by spatial principal component analysis (SPCA) method, which is a modified PCA approach, whose schematic representation is shown in Fig. 7.

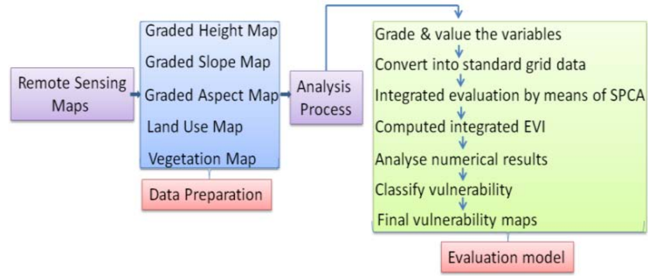

Fig. 7 : Schematic representation of numerical model of environmental vulnerability evaluation by means of spatial principal component analysis

The processes of environmental vulnerability evaluation by SPCA method are explained as follows: (1) to standardize primary data; (2) to establish a covariance matrix R of each variable; (3) to compute an eigenvalue λ_i of matrix R and its corresponding eigenvectors α_i; (4) to group αi by linear combination and put out *m* principal components. According to the cumulative contribution of principal components, the number of components was affirmed 6 and SPCA was accomplished. Then, an evaluation function [97] was setup for computing an integrated evaluation index on the basis of selected components shown as below:

$$E = \alpha_1 Y_1 + \alpha_2 Y_2 + \cdots + \alpha_m Y_m \quad (5)$$

Where, Y_i is no. i principal component, and α_i is its corresponding contribution.

According to each component's weight and generated stack, the algebra computation is worked out and evaluation indexes are put out pointing the situation of regional environmental vulnerability, defined in this paper as environmental vulnerability index (EVI). The higher the EVI value, the more vulnerable environment is.

Table 3 : The results of spatial principal component analysis in the study
Selected principal components

	I	II	III	IV	V	VI
1991						
Eigenvalue	366.88	23.77	10.31	1.06	0.62	.05
Percent of Eigen Values	81.10	5.90	2.56	0.26	0.15	0.01
Accumulative of Eigen Values	81.10	87.00	89.56	90.83	93.98	95.00
2001						
Eigenvalue	824.01	100.1	24.96	9.55	2.64	.95
Percent of Eigen Values	85.63	10.40	2.59	0.99	0.27	0.09
Accumulative of Eigen Values	85.63	86.03	88.63	91.62	94.90	95.10
2013						
Eigenvalue	720.02	76.45	20.86	5.43	1.80	.80
Percent of Eigen	80.60	8.40	2.57	0.81	0.20	0.05

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Values						
Accumulative of Eigen Values	80.60	86.45	89.00	91.71	93.95	95.56

Derived from Table 3 and formula (8), the linear formulas for computing EVI is created as follows:

$$EVI_{1991} = 0.91 * A_1 + 0.06 * A_2 + 0.03 * A_3 + 0.003 * A_4 + 0.002 * A_5 + 0.0001 * A_6$$

$$EVI_{2001} = 0.85 * A_1 + 0.10 * A_2 + 0.03 * A_3 + 0.01 * A_4 + 0.003 * A_5 + 0.0009 * A_6$$

$$EVI_{2003} = 0.89 * A_1 + 0.08 * A_2 + 0.03 * A_3 + 0.008 * A_4 + 0.002 * A_5 + 0.0005 * A_6$$

In the formula, EVI is environmental vulnerability index, *A*1–*A*6 are six principal components sorted out from five initial spatial variables in 1991. Similarly, *B*1–*B*6 are principal components in 2001 and *C*1–*C*6 are the ones in 2013. The cumulative contribution of the six components is 95% (1991a), 95.10% (2001b) and 95.56% (2013c), respectively. Each of them lays in 95%, which accord with the convention of choosing factors by PCA method with a high reliability. However, there is still an information loss of about 5% when the number of selected components reaches six, which shows that the initial factors have relatively independent function on evaluation.

k) Vulnerability gradation using cluster principle

The EVI obtained by integrated vulnerability index calculation was a continuous value. To quantify the environmental vulnerability, the value was classified using the cluster principle and four classes were identified: Slight, light, Medial and Heavy vulnerability (Table 4).

Table 4 : The result of environmental vulnerability classification in the upper reaches of Minjiang River-valley

Evaluation level	Number	EVI	Feature description
Slight vulnerability	I	> 1.5	Relatively stable ecosystem and anti-interference ability, healthy dense vegetation and low altitude
Light vulnerability	II	1.5 - 2	Relatively unstable ecosystem and poor anti anti-interference ability complex vegetation distribution
Medial vulnerability	III	2 - 2.5	Unstable ecosystem, medial human interference, dominated by alpine shrub grass
Heavy vulnerability	IV	2.5 <	Extremely unstable ecosystem, high socio-economic activities, degraded forest

l) Vulnerability change trend

The change trend of environmental vulnerability was analyzed based on two approaches. First is qualitative approach, in that vulnerability values were divided qualitatively into grades: 1.Slight, 2.light, 3.Medial and 4.Heavy vulnerability. The analysis of vulnerability change trends for different years based on the grades of vulnerability was based on the area and area percent, occupied by each vulnerability grade. Secondly a quantitative approach in that the application of the weighted are sum of vulnerability values. The value obtained by calculating the total integrated environmental vulnerability index (EVSI) for each year using the function given by Li et al. 2005 and Brus, et al. 2013 as shown in eq. 6.

$$EVSI = \sum_{i=1}^{n} P_i \; X \; \frac{A_i}{S_j} \qquad (6)$$

In this formula, *n* is the number of valuation grade, EVSI*j* the EVSI in unit *j*, *Ai* the occupied area of grade *i* in analysis unit *j*, *Sj* the area of analysis unit *j*, and *Pi* is the graded value of grade *i*.

In general, the whole change trend can be worked out from change of EVSI value. This paper analyses the change trend through comparing the EVSI value of each period and the distribution of each level.

III. Results

a) Overall Changes

Agriculture and forested land makes up the largest percent of the study area with 35%, 40%, area in 1991 and vice versa in 2013 (Table 5). Forest makes up the largest land-cover, and occurs predominantly in the more upland areas with greater relief. Forest area decrease (222.53 Km^2) slightly during the first half of the study period but then increase (35.78 Km^2) during the second half of the study. Water makes up less than 15% of the upland landscape for all years of the study. Table 5 provides the areas of each class. The total area of the study area was 2000 km^2. From 1991 to 2001, there has been a net decrease of forest is 11.13 percent. But in 2001 to 2013, 6.71 percent forest area was added. Pasture and agriculture was added 4.44 and 5.17 percent respectively from 1991 to 2001 but both area reduce (7.08 and 3.23 respectively) from 2001 to 2013. These changes show governmental protection of forest

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area in between 2001 to 2013. Table 5 shows that no change in number of settlements from 1991 to 2001 but for next decay settlements and water body area were increased.

Table 5 : Land cover areas (km^2) change for 1991, 2001 and 2013

	1991		2001			
Class	**Area**	**%**	**Area**	**%**	**Area Diff.**	**% Diff.**
Water	209.85	10.49	243.77	12.19	33.92	1.7
Forest	804.02	40.2	581.49	29.07	-222.53	-11.13
Settlement	29.87	1.49	26.42	1.32	-3.45	-0.17
Pasture	213.03	10.65	301.75	15.09	88.72	4.44
Agriculture	743.23	37.16	846.57	42.33	103.34	5.17
Total	**2000**	100	**2000**	100		

	2001		2013			
Class	**Area**	**%**	**Area**	**%**	**Area Diff.**	**% Diff.**
Water	243.77	12.19	298.85	14.94	55.08	2.75
Forest	581.49	29.07	715.61	35.78	134.12	6.71
Settlement	26.42	1.32	43.55	2.18	17.13	0.86
Pasture	301.75	15.09	160.09	8	-141.66	-7.08
Agriculture	846.57	42.33	781.9	39.09	-64.67	-3.23
Total	**2000**	100	**2000**	100		

Regarding the management, the analysis of vegetation characteristics shows that in Jesnilk areas, stands are in better condition, with bigger trees showing larger basal area and larger crowns, showing evidence of little exploitation. The low wood exploitation is also unfavorable to the activation of vegetative regeneration for holm oak stands, which may in the long term endanger its sustainability. Conversely, the coppice resource dominates, trees are degraded and the abundance of holm oak coppices emphasizes the intensity of wood exploitation. When tree cover is maintained, it is often due to bushy stands, resulting from the degradation of previous tree clusters. During field visit and key note interviews we find that, tourism and socioeconomic activities are responsible for these land cover disturbance.

b) Types of Change

Change trajectories between the years 1991, 2001, and 2013 were compared on a pixel-by-pixel basis to examine possible land-cover disturbance (Tables 6). Thirty three percent of the landscape remained in the same land-cover class from 1991, 2001 to 2013. Two-date changes (1991–2001 and 2001–2013) show 950 km^2 forest and 3000 km^2 agriculture area was stable in last two decades. 140 km^2 agriculture, 20 km^2 forest and 18 km^2 pasture area encroached by settlements from 2001 to 2013. Stable forest cover mostly was located in high elevation areas of the mountain, especially in Jesenilk, Bruntal, Sumperk and Rymarov.

Table 6 : Types of changes between 1999 and 2013 for areas analysed

Cross table 1991-2001						
CLASS	WATER	FOREST	SETTLEMENT	PASTURE	AGRICULTUR	**Total**
Water	235.38	148.87	0.47	20.04	19.8	**424.56**
Forest	266.97	974.07	8.02	331.45	202.03	**1782.53**
Settlements	0.35	31.94	5.66	39.84	66.12	**143.92**
Pasture	1.53	77.09	2.12	135.31	259.78	**475.84**
Agriculture	12.38	72.37	168.32	333.33	3404.05	**3990.44**
Total	**516.62**	**1304.33**	**184.58**	**859.97**	**3951.78**	**6817.29**
Cross table 2001-2013						
CLASS	WATER	FOREST	SETTLEMENT	PASTURE	AGRICULTUR	**Total**
Water	318.72	161.83	4.6	15.68	19.68	**520.51**
Forest	179.63	988.09	20.39	50.45	57.76	**1296.32**
Settlements	0.12	12.49	11.79	5.54	156.41	**186.35**
Pasture	2.36	462.99	18.74	120.7	262.02	**866.81**
Agriculture	3.3	237.62	140.5	322.02	3239.15	**3942.59**
Total	**504.12**	**1863.03**	**196.02**	**514.38**	**3735.02**	**6812.57**

However, it may not absolutely represent the real land cover disturbance because of the difficulty of modelling the factors influencing this disturbance and the magnitude of human reaction capacity. On the other hand, the pressure exerted on forest depends on the socio-economic and tourist context and may change in the future, according to the disturbance that these societies are experiencing. Indeed, the rapid opening up of the study area due to tourism since the 1980s, the development of commercial agriculture and the national and international development initiatives—electrification in 2002, the introduction of the gas stove, the emergence of the cell phone in 2005, foreign aid offered by different NGOs—have widely contributed to accelerating the land disturbance of practices, as well as creating new production systems likely to partially reduce the pressure exerted on the forest and agriculture. One example of these tendencies is the slight decline of pastoralism, which reduces the cutting of leaf fodder during the cold season.

c) Impact of Tourism

Table 7 summarizes the changes in land cover extent by proximity for all 3 tourism facilities. From 1991 to 2001 forest area was reduce in 0 - 5, 5 - 10 and 10 to 15 km^2 distance in all three tourist site. But it's increase from 2001 to 2013. In Olomouc there is negligible forest area from 0 to 15 km^2 so total area of forest removal is very less. In the village of Rymarov, removal of forest area is more than double of Olomouc. As Jesenilk is very high dense forest area so here removal of forest area was very high. In Jesnilk from 0 - 5, removal of forest is 16.31%, 5 - 10 km is 12.82% and from 10 to 15 km removal of forest is 8.55% area from 1991 to 2001. It could be concluded from this that tourism villages do have an impact on the forest; however, there is considerable geographical variation as shown in table 8. In Olomouc and Rymarov agriculture area was decrease but pasture area was increased from 1991 to 2001 for all 0 to 15 km^2 distance. Both areas were decrease from 2001 to 2013 for all 0 to 15 km^2 distance. For Jesenilk,

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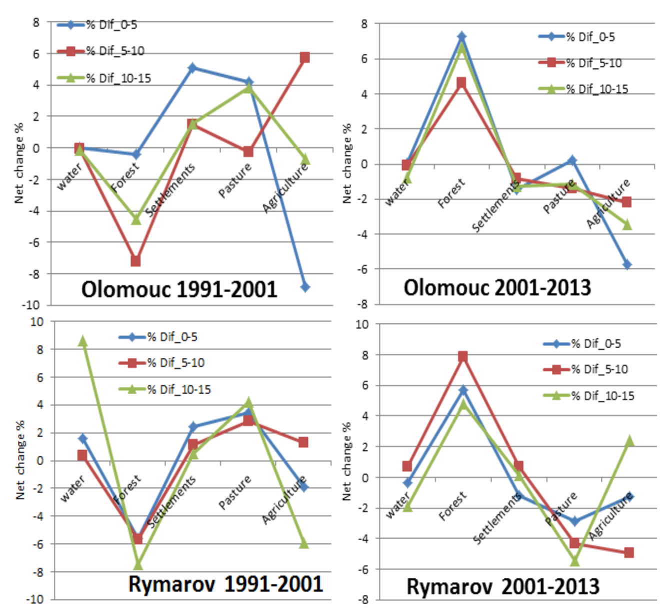
pasture and agriculture both have similar behaviour like Rymarov.

Table 7 : Net land cover change from 0 to 15 km^2 area summary table

Olomouc	0 to 5Km	1991		2001				2013		
Class	Area	%	Area	%	Area Diff.	% Diff.	Area	%	Area Diff.	% Diff.
water	0.34	0.4	0.34	0.4	-0.01	0	0.36	0.43	0.023	0.03
Forest	5.25	6.14	4.78	5.72	-0.46	-0.42	10.92	12.98	6.136	7.26
Settlements	4.35	5.1	8.50	10.17	4.15	5.07	7.02	8.35	-1.478	-1.48
Pasture	2.74	3.2	6.19	7.41	3.46	4.21	6.43	7.64	0.236	0.24
Agriculture	72.75	85.16	63.80	76.31	-8.95	-8.85	59.37	70.6	-4.43	-5.71
Total	85.43	100	83.61	100			84.10	100		
	5 to 10Km									
water	1.70	0.71	2.27	0.95	0.57	0.24	2.05	0.84	-0.22	-0.11
Forest	15.00	6.24	11.21	4.68	-3.79	-1.56	22.60	9.26	11.39	4.59
Settlements	6.82	2.84	10.57	4.41	3.75	1.57	8.65	3.55	-1.92	-0.86
Pasture	8.37	3.48	17.99	7.50	9.62	4.02	14.90	6.11	-3.09	-1.40
Agriculture	208.44	86.73	197.67	82.46	-10.77	-4.27	195.77	80.24	-1.9	-2.22
Total	240.33	100.00	239.71	100.00			243.97	100.00		
	10 to 15Km									
water	8.15	2.07	7.83	1.96	-0.32	-0.11	4.64	1.19	-3.19	-0.77
Forest	50.38	12.77	32.92	8.23	-17.46	-4.53	58.07	14.87	25.15	6.63
Settlements	11.37	2.88	17.66	4.42	6.29	1.54	12.17	3.12	-5.49	-1.30
Pasture	22.25	5.64	37.78	9.45	15.53	3.81	32.49	8.32	-5.29	-1.13
Agriculture	302.50	76.65	303.58	75.94	1.08	-0.71	283.21	72.51	-20.37	-3.43
Total	394.65	100.00	399.77	100.00			390.58	100.00		
Rymarov	0 to 5Km	1991		2001				2013		
Water	2.59	3.13	3.84	4.72	1.25	1.59	3.56	4.34	-0.28	-0.38
Forest	14.88	17.94	10.05	12.35	-4.84	-5.59	14.79	18.03	4.75	5.68
Settlementa	0.98	1.18	2.92	3.58	1.94	2.40	1.98	2.42	-0.93	-1.16
Pasture	4.37	5.27	7.12	8.74	2.75	3.47	4.83	5.89	-2.29	-2.85
Agriculture	60.12	72.48	57.46	70.61	-2.66	-1.87	56.88	69.32	-0.58	-1.29
Total	82.94	100	81.38	100			82.05	100		
	5 to 10Km									
Water	11.77	4.89	25.99	10.88	14.22	5.99	27.56	11.59	1.57	0.71
Forest	92.97	38.62	63.77	26.69	-29.20	-11.93	82.17	34.55	18.40	7.86
Settlementa	3.31	1.37	3.02	1.26	-0.29	-0.11	4.67	1.96	1.65	0.70
Pasture	22.97	9.54	28.12	11.77	5.15	2.23	17.67	7.43	-10.45	-4.34
Agriculture	109.74	45.58	118.03	49.40	8.29	3.82	105.76	44.47	-12.27	-4.93
Total	240.76	100.00	238.93	100.00			237.83	100.00		
	10 to 15Km									
Class	Area	%	Area	%	Area Diff.	% Diff.	Area	%	Area Diff.	% Diff.
Water	27.65	7.01	58.54	15.66	30.89	8.65	55.55	13.75	-2.99	-1.91
Forest	140.70	35.66	105.49	28.22	-35.21	-7.44	133.45	33.03	27.96	4.81
Settlementa	5.33	1.35	6.93	1.85	1.60	0.50	7.88	1.95	0.95	0.10
Pasture	31.96	8.10	46.00	12.31	14.04	4.21	27.84	6.89	-18.16	-5.41
Agriculture	188.95	47.89	156.87	41.96	-32.08	-5.92	179.33	44.38	22.46	2.42
Total	394.59	100.00	373.83	100.00			404.05	100.00		
Jesenik	0 to 5Km	1991		2001				2013		
Water	9.81	11.87	27.437	28.31	17.63	16.44	12.34	15.29	-15.09	-13.02
Forest	31.25	37.82	20.851	21.51	-10.40	-16.31	27.73	34.35	6.88	12.84
Settlementa	1.51	1.83	1.555	1.6	0.04	-0.23	2.48	3.08	0.93	1.48
Pasture	9.74	11.79	11.345	11.7	1.61	-0.09	8.48	10.5	-2.87	-1.29
Agriculture	30.32	36.7	35.74	36.87	5.42	0.17	29.69	36.78	-6.05	-0.09
Total	82.63	100	96.93	100			80.73	100		
	5 to 10Km									
Water	35.25	14.54	31.53	13.86	-3.72	-0.68	57.59	24.01	26.06	10.15
Forest	122.84	50.68	86.11	37.86	-36.73	-12.82	104.04	43.37	17.93	5.51
Settlementa	1.42	0.59	1.20	0.53	-0.22	-0.06	3.71	1.55	2.51	1.02
Pasture	26.98	11.13	37.76	16.60	10.78	5.47	19.97	8.32	-17.79	-8.28
Agriculture	55.91	23.07	70.85	31.15	14.94	8.08	54.57	22.75	-16.28	-8.40
Total	242.40	100.00	227.45	100.00			239.88	100.00		
	10 to 15Km									
Water	40.97	11.55	51.49	14.64	10.52	3.09	78.76	22.14	27.27	7.50
Forest	157.95	44.54	126.54	35.98	-31.41	-8.55	143.81	40.43	17.27	4.45
Settlementa	2.75	0.78	3.77	1.07	1.02	0.30	6.04	1.70	2.27	0.63
Pasture	36.69	10.35	51.78	14.72	15.09	4.38	23.48	6.60	-28.30	-8.12
Agriculture	116.29	32.79	118.09	33.58	1.80	0.79	103.62	29.13	-14.47	-4.45
Total	354.65	100.00	351.67	100.00			355.71	100.00		

The analysis of overall disturbance in Jesnilk area through remote sensing appears that many areas mapped as "stable" also experienced a strong exploitation of vegetation which may have led to qualitative land cover disturbance. More generally, the various canopy cover mapped using remote sensing may show very different morphology, which means that the changes in terms of area and percentage cover revealed by remote sensing analysis may neglect, at least locally, the qualitative disturbance of the vegetation.

Fig. 8 shows the proportional change in forest with increasing distance from the three tourist site. These graphs provide trend lines, which show both positive and negative relationships between land cover change (Forest, Agriculture, Settlements, Water body, Pasture) and distance from villages. A positive trend shows that with less distance from the city/villages there is more removal of forest, agriculture (relative to the forest, agriculture area available), which is what you would expect based on Von Thunen's model of resource use (increasing resource use with decreasing distance to markets). In Olomouc from 1991 to 2001 water was stable, forest, agriculture was go in negative direction and settlement, pasture in positive direction for all three distance (0 – 15 km^2). In 2001 to 2013 forest protected and increase in positive direction. Other classes was stable or in negative direction. In Rymarov forest and agriculture was go in negative direction but rest classes was grow in positive direction from 1991 to 2001. In next decay forest was grow in positive direction but rest classes was stable or over all in negative direction. Jesnilk results are also very much similar to Olomouc and Rymarov (fig. 8). This is showing forest protection from 2001 to 2013. Bruntal, Sumperk, Jeseník, Rymarov, Zabreh, Unicov, Litovel, and Prostejov are in an area of forest and pasture development and located at the northern part of the study area. Hranice, Opava, Krnov, Stemberk, Olomouc,Vitkov, Mohelnice and Prerov are in an area of agriculture oriented and located in south part of study area.



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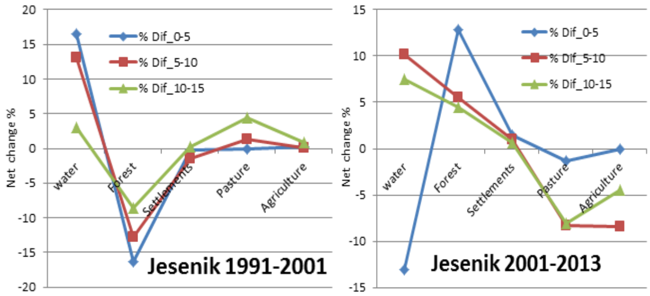

Fig. 8 : Net changes in land cover area around individual tourism facilities

Fig. 8 also displays the separate trends in forest change in relation to distance for each of the three analyzed places. Olomouc is located in the south part of study area and is a relatively large town with plenty of visitors and through traffic from trekkers, tourists, which explains the high level of forest removal. The trend line has a positive relationship indicating decreasing forest removal at greater distance from the settlement. Jesenilk also shows the same positive relationship and a high proportion of forest removal. Rymarov is in an area with little agriculture, suggesting that tourism and socioeconomic activities could be the main reason for forest harvesting. There has also been a road development in this area allowing tourists to reach Jesnilk much faster than in the past. The new road could also make it easier to export logs from this region.

d) Land Classification Change

In the image classification agriculture land makes up the largest percent of the Olomouc region with 37%, 42%, and 39% respectively for 1991, 2001, and 2013 (Fig. 9). Forest makes up the next largest land-cover, and occurs predominantly in the more upland areas with greater relief. Forest area decrease dramatically during the first half of the study period from 40% to 29% but then rigid to 35% during the second half of the study. Other classes make up around 25% of the all over the study area for last three decades.

Figure 9 illustrates the land cover classification results of the study area. This comprehensive analysis of land cover provides both the timing and nature of land cover changes. To simplify for illustration purposes, we categorized three major categories of land cover classes: forest, agriculture and others (settlement, water body and pasture). For example, we can easily derive information since past 30 years. The largest loss of forest was from forest to develop and the largest gain of forest was from barren to forest in the study area. It can also provide new kinds of information about what kind of land cover change occurred on a yearly basis for the entire scene.

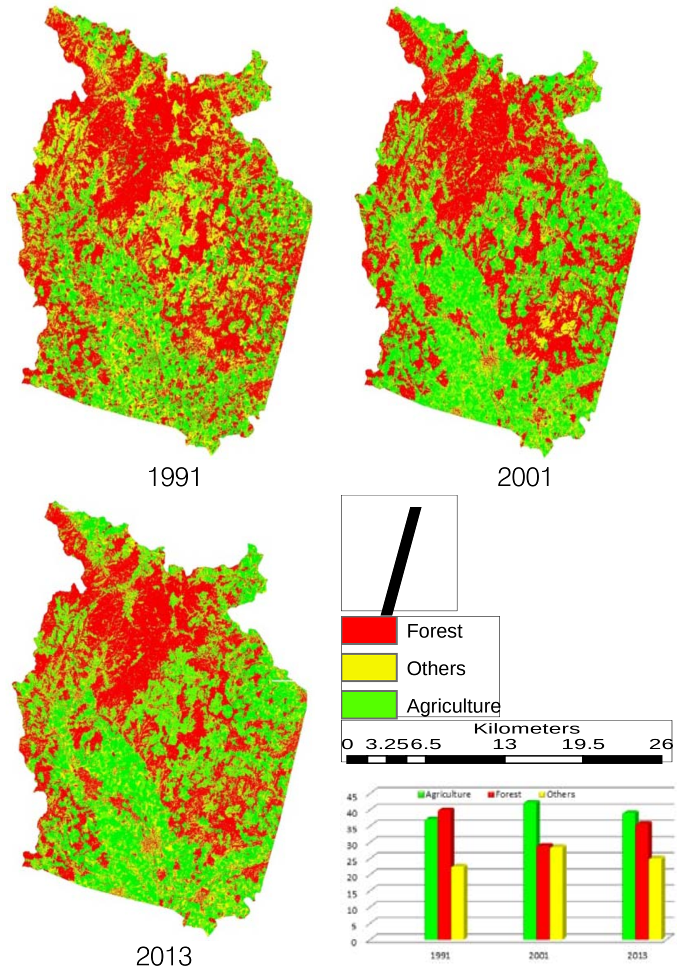

Fig. 9 : Land cover classification for the Olomouc region for 1991, 2001, and 2013

The change that occurred at these pixels was obvious when viewed from the perspective of the entire time series. This approach allows the identification of the timing of each change, as well as the kind of change. When the time series has been built for a pixel and analyzed for change, it is possible to use the estimated time series models between the changes to identify the land cover class for the pixel at different time periods. For the pixel located at first year, the estimated model preceding the change in 1991 can be used to classify the land cover for the entire time prior to the change. Similarly the estimated method subsequent to the change can be used to identify what land cover came after the change in 1991. The shape of the time series method can be very helpful in land cover classification which is evident in the time series graphs at the bottom, as initially pixels located in year 1991 and 2013 were conifer forest and pixel located in 2001 was a hardwood forest, and they are readily distinguishable by the difference in the amplitude of their time series.

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Table 8 : Results of land use/land cover classification for 1991, 2001 and 2013 images showing area of each category and class percentage

Class	1991	%	2001	%	2013	%
Agricultur	743.23	37.16	846.57	42.32	781.9	39.09
Forest	804.02	40.02	581.49	29.07	715.61	35.78
Others	452.48	22.62	571.94	28.59	502.49	25.12
Total	2000		2000		2000	

e) Change Detection

Figure 9 shows the land cover classifications produced for 1991, 2001 and 2013 from Landsat images, and figure 10 shows the areas of forest addition and removal. Table 8 provides the areas of each class. The total area of the study area was 2000 km^2. From figure 9, it is clear that most of the forest is in the northern part of the study area, which has higher elevation and higher rainfall. This area has larger trees suitable for timber production and is closer to major urban areas, such as Bruntál, Šumperk, Jeseník, Rýmařov. In this area there has also been forest added but this was less than what has been removed. In the flat southern region, figure 10 shows that more forest has been removed than added, but the extent of this change was small compared to the changes in the north. The spatial analysis in relation to socio-economic activities confirms this.

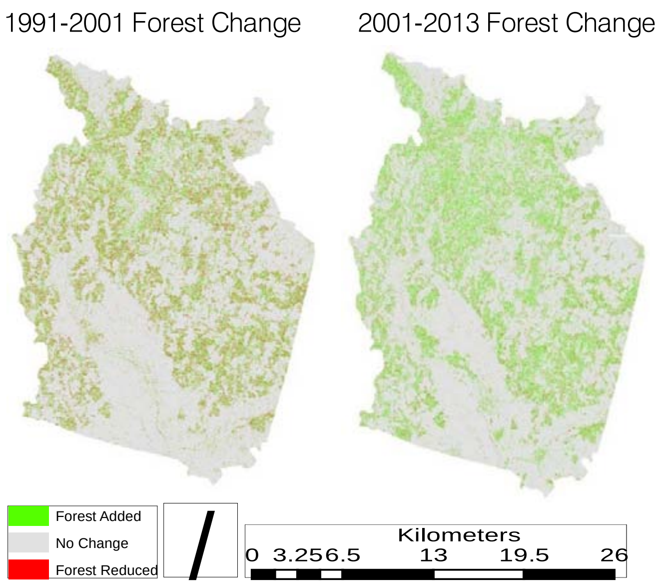

Fig. 10 : Increase and decrease in forest cover

Change trajectories between the years 1991, 2001, and 2013 were compared on a pixel-by-pixel basis to examine possible land-cover disturbance (Tables 9). Thirty three percent of the landscape remained in the same land-cover class from 1991 to 2013. Two-date changes (1991–2001 and 2001–2013) show that, 2300 km^2 forest and 1500 km^2 agriculture area was stable in last two decades. 140 km^2 agriculture, 20 km^2 forest and 18 km^2 pasture area was encroached by settlements from 2001 to 2013. In 2001, 260 km^2 other classes and 480 km^2 agriculture area added in forest area. 313 km^2 others and 127 km^2 agriculture areas were removed from forest area from 1991 to 2001. 118 km^2 agriculture and 245 km^2 other class area added in forest class. Stable forest cover area was mostly located in high elevation area of the mountain, especially in Jesenilk, Bruntal, Sumperk and Rymarov.

Table 9 : Types of changes between 1999 and 2013 for areas analysed

1991-2001	Forest	Others	Agriculture	Total
Forest	2340	313	127	2780
Others	262	427	437	1126
Agricultur	480	901	1525	2906
Total	3082	1641	2089	6812
2001-2013	Forest	Others	Agriculture	Total
Forest	2348	277	467	3092
Others	245	477	902	1624
Agricultur	118	479	1495	2092
Total	2711	1233	2864	6808

This study employed the post-classification change detection technique, which was efficient in detecting the nature, rate and location of changes, and has been successfully used by a number of researchers in the study of natural resources [97]. An overlay procedure using the GIS was adopted in order to obtain the spatial changes in land cover during two intervals: 1991–2001 and 2001–2013. Application of this technique resulted in a two-way cross-matrix, describing the main types of change in the study area. Cross tabulation analysis on a pixel-by-pixel basis facilitated the determination of the quantity of conversions from a particular land cover class to other land use categories and their corresponding area over the period evaluated. A new thematic layer containing different combinations of ''from–to'' change classes was also produced for each of the two three-class maps (Table 9).

Using the Landsat datasets, we calculated producer accuracy for all potential change pixels at three decade time steps. In the study area, within-class and between-years reveal different characteristics of change. Figure 10 shows examples of within-class and between-years changes for 1991-2001 and 2001-2013. The within-class distances appear to highlight the contrast between forest and non-forest areas in a given year. The between-year changes are noisier, but highlight locations with large differences between two years including newly changed areas and agricultural areas that were inherently more variable.

f) Analysis Based on Trajectories

This three decade trajectories analysis was focus on forest, agriculture and different factors drive changes in the region. Two-date changes (1991–2001 and 2001–2013) show stable non-forest (agriculture and

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others) areas cover over 38% landscape while stable forest cover (F–F) drops from 54% (Table 10). In the study area old permanent agriculture regrowth and regrowth with new clearing class was 1.07% of the total area. Forest regrowth with new clearing and old permanent forest regrowth area was around 4% of the total area. Old permanent agriculture clearing area was approximately 2% of the total area. The 3-date change trajectories allow us to determine a single pixel's trajectory over time with more details (Table 10).

In the study many small fields were cleared and then were reforested (O–F–F), while many other small areas had O–F–O trajectories. Our field observations demonstrated that these were smallholder fields of shifting agriculture that were growing maize, pineapples, or other cash crops that were probably used in restaurants in Olomouc region. There was not any recent agriculture regrowth (O–O–A) and recent forest regrowth (O–O–F) class in the study area. But due to some specific location requirement old agriculture with regrowth (A–O–A) and old permanent agriculture clearing (A–O–O) was present (Fig. 11).

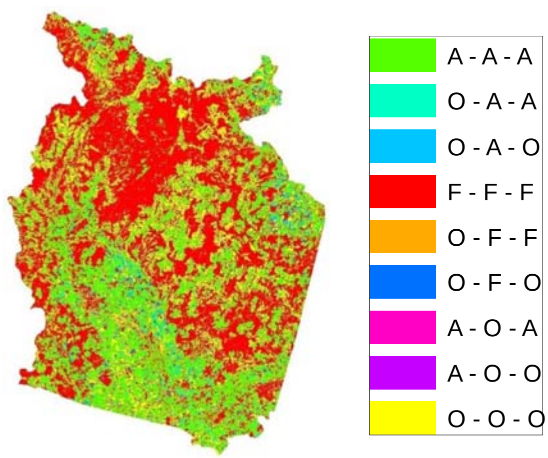

Fig. 11 : Land-cover classification trajectories for 1991–2001–2013 in the Olomouc. ''F'' refers to forest, "A" agriculture and ''O'' to other classes (pasture, settlements, water body)

After change trajectory calculation, distribution map of all the trajectories in the study area from 1991 to 2013 were generated. In the map, green, red and yellow pixels stand for "no change", while others stand for all kinds of "change". However, some trajectories would never happen and some others may take much small parts in all the trajectories so that they can be omitted. Through majority analysis with a 5×5 mask, the scattered trajectories with small count numbers in the whole area were assigned the value of neighbors in majority. It suggests that these changes were extensively induced by organized human activities, which coincides with the local practical situation. The study area suffers serious soil losses, which has brought great damage to the local residents. In order to conserve soil, the government has called on the local people to take measures to better the ecological environments.

Table 10 : Land-cover change trajectories in Olomouc and their descriptions 1991, 2001, 2013

	Change trajectory			Description	Area (km^2)	%
	1991	2001	2013	LULC change classes		
1	Agriculture	Agriculture	Agriculture	Stable primary or secondary agriculture	333.79	16.69
2	Other	Agriculture	Agriculture	Old and permanent agriculture regrowth	11.57	0.58
3	Other	Agriculture	Other	Agriculture regrowth with new clearing	9.88	0.49
4	Forest	Forest	Forest	Stable primary	1086.57	54.33

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6	Other	Forest	Other	Forest regrowth with new clearing	61.66	3.08
7	Agriculture	Other	Agriculture	Old agriculture clearing with regrowth	8.32	0.42
8	Agriculture	Other	Other	Old and permanent agriculture clearing	38.76	1.94
9	Other	Other	Other	Stable primary or secondary others	439.64	21.98
10	Other	Other	Agriculture	Recent agriculture regrowth	-	-
11	Other	Other	Forest	Recent forest regrowth	-	-

During the first and second periods, the main trajectories were dominated by deforestation transitions that led to the decline of old growth forests and the increase of arboreous shrub land as a result of logging practices. A remarkable finding was, however, that the transition from old growth forest to arboreous shrub land changed from highly systematic in the first period to highly random in the second, similar to the majority of the transitions affecting native forest cover between 1991 and 2001. This finding suggests that the same type of transition (deforestation in this case) can be caused by either permanent or sudden forces that take place in the landscape. In the study area, the period of random changes (and coincidentally of a large amount of swap change) coincides with the beginning of the globalization process, characterized by trade liberalization policies and structural adjustment reforms which opened up the economy to international trade, favored international investments, and reduced the role of the state in favor of market mechanisms to drive development [98]. The arrival of salmon and mussel farming and the transnational processing industries shows us how the globalization process manifested itself in the study area. During the 1991 and 2001's, rural migration rates and urban population increased, thus expanding the demand for firewood, the main product extracted from native forests in northern part. Added to this increased logging, the "woodchips exporting boom" (early 1990's to mid-2000's), led to abrupt deforestation, as indicated by the direct change from old growth and secondary forest to shrub lands through clear cutting.

g) Correlation in vulnerability index and exposer index for all land cover classes

VI was calculated based on the results of SI and AI (Eq. 2). The values of VI and EI in five land cover classes are presented in Fig. 12. The result demonstrates that vulnerability of land cover classes tends to increase with the increase of Exposure Index, although this correlation does not follow a linear trend. Settlement is the most vulnerable one in five land cover classes. Explanations for the curve are: (1) water class follows relatively slow process of change, and still maintain stability. (2) Land use is changed rapidly in settlements, forest and agriculture, leading to rapid socio-economic transformation. The traditional agricultural system is collapsing, but emerging system on industry and commerce is trying to establish. These changes make the system vulnerable. In other words, these land-cover classes lost too much and gain too little from development. (3) Agriculture area encroached by other classes for commercial and urban residential and that`s why exploited most. Economic development and land use type are both relatively stable. No change or stable areas have much time to adjust in these changes and show stronger adaptive capacity.

Table 11 : Land use/cover area in three decade

	1991		2001		2013	
Class	**Area**	**%**	**Area**	**%**	**Area**	**%**
Water	209.85	10.49	243.77	12.19	298.85	14.94
Forest	804.02	40.2	581.49	29.07	715.61	35.78
Settlement	29.87	1.49	26.42	1.32	43.55	2.18
Pasture	213.03	10.65	301.75	15.09	160.09	8
Agriculture	743.23	37.16	846.57	42.33	781.9	39.09
Total	**2000**	100	**2000**	100	**2000**	100

Comparing of EI and VI for last three decades, water have lowest vulnerability index and settlements have highest vulnerability index due to high socio-economic activities (Fig. 12). Agriculture has highest exposer index and second highest vulnerability, which

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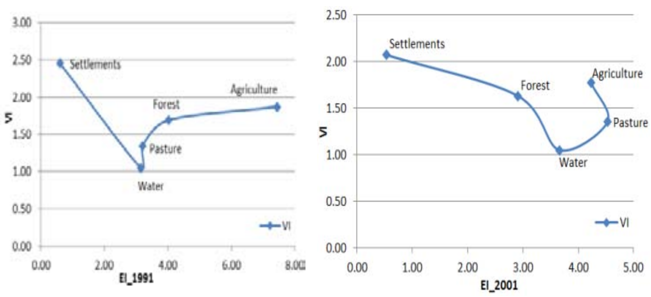
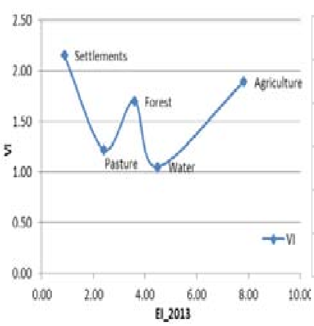
show its high rate of production and conversion. From 1991 to 2001 exposer intensity was reduced due to utilization of pasture area. Forest area have very less variation in vulnerability from 1991 to 2013 but its exposer was high from 1991 to 2001 and then stable due to governmental protection from 2001 to 2013. Water class is stable but from 2001 to 2013, its exposer was little bit high due to urbanization and industrialization. Pasture area have always second lowest vulnerability and low exposer rate but it was highest exposed in 2001 because it was used in place of agriculture land (Fig. 12).





Class	EI_1991	VI	EI_2001	VI	EI_2013	VI
Settlements	0.6	2.45	0.53	2.07	0.87	2.15
Pasture	3.2	1.34	4.53	1.35	2.40	1.22
Forest	4.02	1.69	2.91	1.63	3.58	1.70
Water	3.15	1.05	3.66	1.05	4.48	1.05
Agriculture	7.43	1.87	4.23	1.77	7.82	1.89

Fig. 12 : Correlation of Vulnerability Index (VI) and Exposure Index (EI)

Figure 13 shows all land cover class change gradient of development. From a temporal perspective, all land cover classes in Olomouc was transformed into developed area in different time frame because of the higher exposer intensity in agriculture area. In 1991 all classes were less developed in compare of 2013. Then these all classes underwent the transformation process respectively in the 1991, 2001 and 2013, which included three stages: land acquisition for construction, industrial estate development and improvement of urbanization or settlements. This process started in settlements in 1991 and later in other classes. Spatial gradient of vulnerability five land cover classes in 2013 can be considered as representing temporal gradient of one land cover class in five stages. Therefore, the results of vulnerability analysis over area helped us to know how vulnerability of an area land use change process. Undeveloped or less developed area was vulnerable within the land use change process. However, with resilience in difficult situations, it was adaptive and less vulnerable after its turning into developed area.

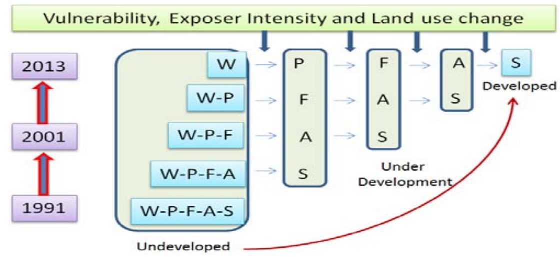


Fig. 13 : Transformation of five land cover classes over past 3 decades. S = Settlements, A = Agriculture, F = Forest, P = Pasture, W = Water

Generally, the curve of VI–EI is an inverted-U shape, which means VI will raise at first and drop later with the growth of EI. Besides, we cannot conclude every land cover class would develop through the path from rural stage to urban stage. In this case, the land use intensity of water did not change significantly during 1991–2013, the EI and VI of water was the least. If the land use will not evolve from agriculture to industrial and finally to urbanization in this area, the VI might decrease, considering the AI will improve with the development while the SI will remain stable. Furthermore the five stages are definitely typical ones, because they represent four types of driving forces for land use change, which are agricultural, governmental, industrial, and commercial forces (Fig. 13). Agricultural force is the weakest one with the limit of productivity. Governmental and industrial forces always get entangled and are the most powerful forces to change the land use intensity. It is a weak pressure on land use intensity that land use type changes from industrial use to commercial use or residential use. These findings suggest that the more powerful driving force, the more pressure on land use intensity and the more the impact on natural resources. However, if the land covers classes own a strong adaptive capacity; their vulnerability can be trailed off [99].

Table 11 presents characteristic of environmental vulnerability level and EVI. Stability is the main parameter for environmental vulnerability levels. The calculated values of EVSI of the study area for each year and percentage area of each vulnerability levels are presented in Table 12. Change trends show that EVSI decrease continuously from 2.11 to 2.01 from the year of 1991 to 2013. Results show that: (a) during 1991 and 2001, slight and heavy vulnerability levels had decreased by 33.83% to 27.16% and 11.20% to 0.85% respectively. Where light and medial vulnerability increased 31.95% to 39.20% and 23.02% to 32.79% respectively. (b) During 2001 to 2013, slight and heavy vulnerability increased by 27.16% to 32.04% and 0.85% to 4.55% respectively. However, in the same period light and moderate vulnerability were decrease from 39.20% to 39.15% and 32.79% to 24.26% respectively. Medial environmental vulnerability was shown in entire three decade period.

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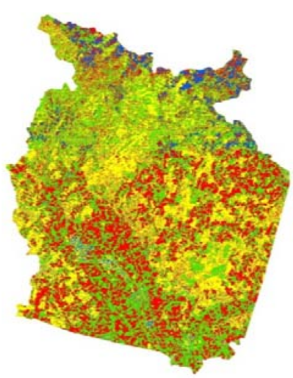
Table 12 : Computed results from formula 3 and percentage area of each vulnerability level

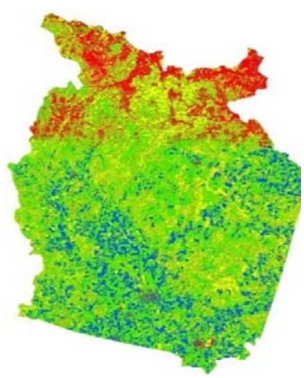
Vulnerability	1991			2001			2013		
	Area	%	EVSI	Area	%	EVSI	Area	%	EVSI
Slight	676.69	33.83		543.15	27.16		640.86	32.04	
Light	638.96	31.95		784.07	39.20		782.96	39.15	
Medial	460.37	23.02	**2.11**	655.75	32.79	**2.07**	485.26	24.26	**2.01**
Heavy	223.98	11.20		17.03	0.85		90.92	4.55	
Total	**2000.00**	**100.00**		**2000.00**	**100.00**		**2000.00**	**100.00**	

h) Vulnerability Grade

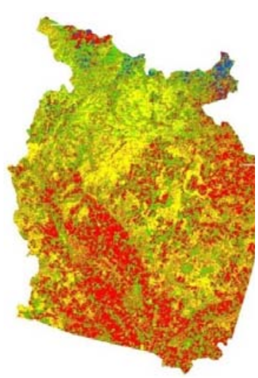
Vulnerability evaluation showed in figure 14 and 15 for the year 1991, 2001 and 2013. The general environmental vulnerability trend shown in table 12 that the situation in 2013 with an EVSI 2.01 is better than 2001 with an 2.07 and latter is better than 1991 with an 2.11. The high value of EVSI means more serious situation. It show that the light vulnerable zone lies within average-value range with the largest area proportion accounting for 31.95%, the medial vulnerable zone account for 23.02%, the slight vulnerable zone account for 33.83%, and the heavy vulnerable zone accounts for 11.20%. The profile of index shows an asymmetry normal distribution and the center of profile lean to "medial" level in 1991, shown in Fig.1 4. In 2001 slight, light, medial and heavy vulnerability was 27.16%, 39.20%, 32.79% and 0.85% respectively. And in 2013 slight, light, medial and heavy vulnerability was 32.04%, 39.15%, 24.26% and 4.55% respectively.



Vulnerability 1991



Vulnerability 2001



Vulnerability 2013

Fig. 14 : Environmental vulnerability maps of the study area

Landscape stability of the study area was observed to be very dynamic. The area is under the influence of different land use activities namely agriculture, infrastructure development, mining and industry. Based on the influences of these activities, the size of the area characterized by each degree of vulnerability in each year has also been changing in a floating pattern. There is neither continuous increase nor decrease of a particular vulnerability grades. Through the visual interpretation of fig. 14 above, the heavy vulnerability grade seem to extend outwards all directions from the center.

i) Geographical Distribution of Vulnerability

Figure 15 shows that heavy environmental vulnerability was very high in 1991 but it was very less in 2001 due to protection of forest and then again little bit increase in 2013. Heavy vulnerability is present in areas, which is related to socio-economic activities. Slight and light environmental vulnerability is present in stable forest or low human impact areas. Percentage levels for slight and light increased, while it decreased for moderate and heavy levels as the altitude increased. Environmental vulnerability related to slope at low to moderate levels was found to be confined between 20° to 50°. However, heavy vulnerability level was recorded in a steepest slope situation. Slight and light vulnerability levels concentrated in north, north-east, north-west and west aspects. While medial and heavy vulnerability levels concentrated in south, southeast, south-west and west aspects. The maximum values of medial and heavy vulnerabilities were recorded in south-west and central part of study area.

The EVSI apparently presented distinct geographical distribution. The study area characterized by typical mountainous area showed landforms rising and falling violently. Mountain spread, slope direction and degree, and vertical changing climate cause great difference in natural resources and consequently on the human activities [100]. In lower altitude environmental vulnerability is high due to more socio-economic activities and human interferences such as regular constructions of roads and settlements, extensions of agriculture area and forest encroachment or degradation. But in high altitude vulnerability is low due to less socio-economic activities and human interferences as environmental conditions for human activities were not favorable. The greater environmental vulnerability threats at steep and very steep slopes resulted from serious soil erosion, low soil moisture, high landslide possibility and poor soil fertility problems. The overall study area environmental vulnerability is light with an around 40%, based on natural factors. The study area is characterized by typical middle-high mountainous area with landforms rising and falling violently. The highest elevation is 1500m. This mountain region have pumped storage hydro power plant. It has

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the largest reverse hydraulic turbine in Europe – 325 MW, it is the power plant with the highest gradient in the Czech Republic – 510.7m and has the highest installed output among the hydro power plants in the Czech Republic – 2*325 MW. It shows that the results strictly represent regional feature.

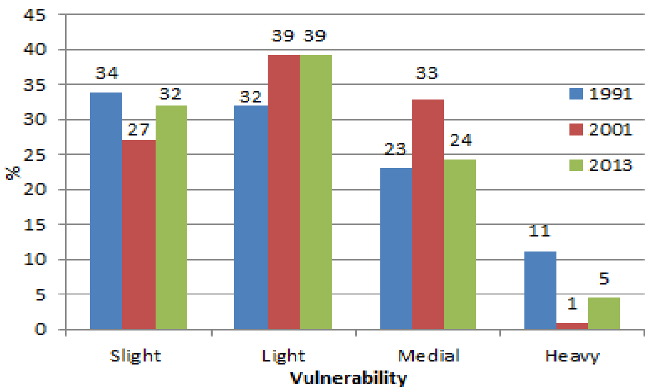

Fig. 15 : Environmental vulnerability maps of the study area

Last three decades environmental vulnerability trends are changes and basically based on forest damage or encroachments. Few other factors are also important such as landforms, water heat condition and soil types [101]. These factors directly related to socio-economic activities, resulting the increase pressure of human on land, which lead to rapid changes of land use. Thus, the coverage of land is cutting down, and soil erosion is intensified eventually, resulting in a further degradation of eco-environment.

IV. Discussion

At lower altitudes, a mixture of agriculture and forestry should be implemented. However, to meet the needs of the local population and tourist that would grow substantially in the next 5 to 10 years, a portion of the land must be used for grain production. Nevertheless, some of this land could be reused for forestry at some time in the future. The recommended reallocations were tested in a few experimental sites and more or less reflected the land use practice in reality. As in any assessment, though, accuracy of the final results was subject 1.0 the accuracy of the input data layers. Some data (e.g., land cover) had a definite boundary, whereas other variables *(e.g.,* climate and socio-economic) had a vague boundary. Therefore, the final results involved some uncertainty and should be treated with caution.

The irrational way of land use such as conversion from woodland to farmland has led to land degradation. However, through reallocation of land that has been excessively exploited to a new use (commensurate with its potential, this problem could be remedied. The recommended optimal allocation emphasized the ecological suitability for exploitation of natural resources and encouraged mixed farming with forestry, pasture and stockbreeding [102]. Naturally, switching from farming to forests would reduce grain output. However, improving farmland productivity through construction of irrigation facilities as well as converting the existing sloped farmland into terraced land to conserve soil and water could compensate these decreases.

Nevertheless, successful implementation of these recommendations relies on other related measures [103]. Those farmers disadvantaged by the reallocation should be compensated for their economic loss in the form of a government-sponsored grant. In this way farmers' livelihoods would not be negatively affected. Another means of achieving the reallocation was through cultivation of medicinal herbs. As a perennial vegetative cover these plants could prevent soil erosion. Finally, to reduce overpopulation, reallocation of some of the rural population should be encouraged. With these measures the recommended reallocation could ensure sustainable exploitation of land resources in the study area.

In this case study, our findings indicate that the rationality in forest use still remains unworkable due to the absence of alternatives that would reconcile the ecological resilience, the mitigation of the current degradation trends, and the population's needs for livelihood. More specifically, the failure of natural resources management seems also to rely on the impossible equation between growing population needs and the physically limited production capacity of the natural environment (soils, climate) leaving no place to intensification, except with substantial inputs from outside the system. Such a saturation of traditional systems, triggered mainly by the population growth, is widely occurring in many places throughout the world [104. The solution relies on a deep transformation of the traditional system, typically changing from self-sufficiency to a higher level of connection with the external economy (people working in cities, multiplication of income sources). This explains why some forests close to urban areas may be in bad condition than forests located in remote traditional areas. A comparable environmental breakpoint was reached in the Czech in 19th century, with a very strong degradation of mountains areas triggered by tourist and population growth, and was overcome during the 20th century with the transition from a self-sufficient production to a wider opening to the national economy.

This work provides an empirical assessment of land cover change dynamics in Olomouc region. The results show that forest cover change involves a series of complex trajectories, some of which are cyclical and reversible, while others are more linear and permanent. These diverse trajectories are consistent with a highly

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dynamic landscape dominated by forms of small-holder land use that reflect heterogeneous livelihood strategies. In-depth analysis of the transition matrices allowed us to separate systematic from random transitions, which revealed unexpected dynamics. Usually, in rural landscapes dominated by peasant farming systems, forest cover loss is attributed to shifting cultivation. Our results, however, show that native forests have been systematically replaced by a range of other covers and land uses over time, and that agricultural expansion is just one of the direct causes of forest decline.

In the last period (2001-2013), most forest cover transitions became systematic again, driven by new forces that led to different cycles of old growth forest decline. The most systematic transition and relevant in terms of magnitude, was the change of old growth to secondary forest at an average annual rate. This very recent forest degradation relates mostly to peasant agricultural systems and can be associated to an increasing firewood demand from an expanding population in urban areas outside of the cities/villages [105, 106].

The above land use change trajectories and trends indicate significantly increasing pressure on available land resources in the study area, leading to the cultivation of increasingly marginal areas, which again leads to dramatic soil fertility decline. It is imperative that these trends are taken into consideration when developing strategies for agricultural development in Olomouc. However, it may not absolutely represent the real land cover disturbance because of the difficulty of modelling the factors influencing this disturbance and the magnitude of human reaction capacity. On the other hand, the pressure exerted on forest depends on the socio-economic and tourist context and may change in the future, according to the disturbance that these societies were experienced. Land use/cover changes were mainly caused by human activities and natural forces [107, 108].

Overall, the results reflect the conflicting interactions between physical and human systems in the study area. In this respect, a key question to address is how to generate the incentives that move individuals from conflicting relations with their natural system, toward more sustainable landscape transitions and trajectories without the regulatory presence of the government (e.g. a ban on logging). Worldwide, land is private property and its usufruct is an important right for the landowner, which implies its free use and also determines its value [109, 110]. The forest dynamics described in this study to systematic economic forces such as firewood and industrial timber demand. If these landowners continue to degrade their forest resources at the rates observed between 1991, 2001 and 2013, by 2020 few and small patches of old growth forest can be expected to remain [111, 112].

V. Conclusions

This research provides evidence that the impact of tourism on land cover in the Jesenik mountain tourist region. Forest area decrease closer to city and its increase after 10 km distance of the city. Tourism facilities have closer proximity and associated with a decrease in forest extent. However this research cannot say that all land cover disturbance are due to only tourism but there are some other factors such as agriculture expansions, timber harvesting, wind and snow damage could also responsible for land cover disturbance. It appears that due to market demand forest harvesting, agriculture, pasture, water body and settlement area is increasing. Climate and elevation is also effect on their extensions. Population growth and increasing of socio-economic activities are also responsible for the land cover disturbance.

In this research work, land cover change trajectories for three different dates from 1991 to 2013 were extracted from satellite imageries by object oriented classification methods. Classification results were calibrated with ground truth trajectories. These results are useful to spatio-temporal variability of landscape pattern and their change trajectories with natural factors. Analysis based on these landscape trajectories demonstrates that major parts of land use/cover changes have been caused by human activities, most of which, under the direction of local government, have mainly led to virtuous change in the study area. This study was carried out on small study area with three major land cover classes. The significant body of data containing accurate spatial and thematic detail that was yielded by the analysis sheds considerable light on recent land cover and its dynamics. So in the later research, more influential factors would be taken into the analysis, including some human geographical factors and economic geographic factors, such as transport, social economy and so on.

Our results have important policy implications, for developed and developing countries that are undergoing rapid urbanization and industrialization. This conversion increases the vulnerability and exposer. Urbanization has negative impacts, particularly as a cause of environmental pollution derived by intensive energy consumption and material flows, and leading to dramatic changes in land use, loss of biodiversity, habitat fragmentation and a decline in ecosystem services which is the main cause of high vulnerability and exposer index. This case study articulated the effects of land use change and offered a vulnerability analysis framework for sustainability. The measurement of vulnerability and exposer can be appropriate and useful to identify vulnerable people, region or sectors at local scales under strict conditions. Our comparison of vulnerability and exposer index in different land cover classes that are undergoing similar transformation

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process but with a clear time lag may shed some lights to temporal trend of vulnerability and expose within a single land cover class that follows similar transformation trajectory. Further studies in different areas are required before any general conclusions can be made. Nevertheless, the results have strong policy implications, which suggest the need for tailor-made policy responses to enhance adaptive capacity of land cover class that are exposed to rapid land use change, and ensure the development associated with the land use change can benefit the local community as well.

This research show environmental vulnerability in a mountain area and evaluates the situation with the support of remote sensing and GIS. SPCA method was used for weights and membership of all factors. It finds that over all study area environmental vulnerability is light level and its distribution is vertical and horizontal nature. As EVSI reduced from 1991 to 2013 so it`s assume that vulnerability is reducing due to governmental policies and protection. The main cause of environmental vulnerability is socio-economic activities. The results indicate it is urgent that, besides the improvement and reinforcement of compensation mechanism construction, the work of eco-environmental recovering and rebuilding should be carried out according to regionalization. Results also indicate that RS, GIS and SPCA approach are good in mountain region for environmental vulnerability evaluation. They also facilitated the derivation and application of the numeric environmental vulnerability evaluation. These findings provide quantitative basis and support for forest policy, management issues and institutional analyses in planning and management of the mountain regions.

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Low Cost Construction Material for Concrete as Sawdust

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Abstract- In this Research paper, it was experimentally carried out to investigate the effects of introducing the cost between sand used concrete block and sawdust used concrete block. For making the concrete blocks we are using coarse aggregate, fine aggregate, cement, water and sawdust to mix it. Using some percentage of sawdust in place of sand in concrete is used. We replace replaces 10%, 15% and 20% of sawdust instead of sand while other things are same. After making the concrete blocks I am going to see the difference in weight between the originally concrete block and the sawdust concrete block. The unit density of the concrete block is tested also. Research paper has proved that saw dust Concrete can be used as a Structural Concrete at suitable replacement percentage and also affects the cost of the construction.

Keywords: saw dust, structural properties, strength.

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Low Cost Construction Material for Concrete as Sawdust

Dilip Kumar [α], Smita Singh [σ], Neetesh Kumar [ρ] & Ashish Gupta [Ѡ]

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I. Introduction

Sawdust is a by-product of cutting, grinding, drilling, sanding, or otherwise pulverizing wood with a saw or other tool; it is composed of fine particles of wood. Certain animals, birds and insects which live in wood, such as the carpenter ant are also responsible for producing the saw dust. Sawdust has a variety of other practical uses, including serving as mulch, as an alternative to clay cat litter, or as a fuel. Until the advent of refrigeration, it was often used in icehouses to keep ice frozen during the summer. It has been used in artistic displays, and as scatter. It is also sometimes used to soak up liquid spills, allowing the spill to be easily collected or swept aside. As such, it was formerly common on barroom floors. Mixed with water and frozen, it forms pyrite, a slow-melting, much stronger form of ice. Sawdust can be used as alternative substitute for fine aggregate in concrete production. Before using the saw dust it should be washed and cleaned. because of large amount of barks are present which can affect setting time and heat of hydration of cement. Concrete obtained from sawdust is a mixture of sawdust, gravel with certain percentage of water to entrance the workability and full hydration of the cement which provide great in bonding of the concrete. Sawdust concrete is light in weight and it has satisfactory heat insulation and fire resisting values. Nails can be driven and firmly hold in sawdust concrete compare to other lightweight concrete which nail can also easily drive in but fail to hold construction community might well be aware of, incorporating organic materials into solid concrete is not such a good idea to begin with. First of all, its loose molecular structure would cause the structure to fail at a certain stage and second, it would compete and retard the hydration process of cement. Also, presumptions indicate that if each sawdust particle took up enough water during hydration, they could aid the hydration process especially in the center parts of concrete that is impossible to cure with water thus eliminating the need of curing because water deposited in sawdust particles are being harvested by cement particles. The most important aspect and main target of the experiment are proving that sawdust-cement-gravel mixtures can prove to be more lightweight and cost efficient. Since sawdust is already waste then the cost would go down as well as weight cause of its extremely light unit weight. Sawdust is used in concrete more than 40 years.

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II. Materials Used

a) Saw dust

Sawdust is also known as wood dust. It is the by-product of cutting, drilling wood with a saw or any other tool; it is composed of fine particles of wood. Certain animals, birds and insects which live in wood, such as the carpenter ant are also responsible for producing the saw dust.

Sawdust's are produced as a small discontinuous chips or small fragments of wood during sawing of logs of timber into different sizes. The chips flow from the cutting edges of the saw blade to the floor during sawing operation.

Table 1 : Chemical characteristics of Saw dust

S.N.	Constituents	Percentage (by weight)
1.	SiO_2	87
2.	Al_2O_3	2.5
3.	Fe_2O_3	2.0
4.	MgO	0.24
5.	CaO	3.50
6.	Loss on ignition (LOI)	4.76

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Table 2 : Physical Characteristics of of Saw dust

S.N.	Properties	Value
1.	Optimum moisture content (%) (OMC)	19.80
2.	Maximum dry density(g/cc) (MDD)	1.40
3.	Specific gravity (G)	2.15
4.	Cohesion C (KN/m^2)	7
5.	Angle of internal friction	30^0
6.	Un-soaked CBR (%)	5.2
7.	Soaked CBR (%)	2.95
8.	Free swell index	80
9.	Soil classification	ML

Figure 1 : Saw Dust

b) Cement

Cement used in the experiment work is White Portland cement conforming to IS: 8042-1989.The properties of White cement are nearly same as OPC. A typical test result of Birla White Cement as given by manufacturer is shown in following Table.

Table 3 : Chemical Properties of Cement

Characteristics	IS:8042:1989	Birla White Portland cement
Insoluble residue(%)	Max 2.0	0.60
Iron oxide(%)	Max 1.0	0.20
Magnesium oxide(%)	Max 6.0	0.80
Sulphur trioxide(%)	Max 3.0	2.90
Alumina/iron oxide(%)	Min 0.66	9.00
Lime saturation factor	0.66-1.09	0.90
Loss of ignition(%)	Max 5.0	<3.00

Table 4 : Physical Properties of Cement

Characteristics		IS:8042:1989	Birla White
Degree of whiteness%		Min 70	88+
Fineness(m^2/kg)		Min 225	450
Setting time	Initial(min.)	Min 30	80
	Final(min.)	Max 600	120
Compressive Strength (cement and standard sand mortar 1:3)	3 days (MPa)	Min 14.4	45
	7 days (MPa)	Min 19.8	55
	28 days (MPa)	Min 29.7	67
Soundness	Lechateliers method(mm)	Max 10	1.0
	Autoclave expansion%	Max 0.8	Negligible
Retention on 63 micron sieve(%)		-	1.0

c) Fine Aggregates

Fine aggregate was purchased which satisfied the required properties of fine aggregate required for experimental work and the sand conforms to zone III as per the specifications of IS 383:1970.

- Specific gravity = 2.7
- Fineness modulus = 2.71

d) Coarse Aggregates

Crushed granite of 20 mm maximum size has been used as coarse aggregate. The sieve analysis of combined aggregates confirms to the specifications of IS 383: 1970 for graded aggregates.

- Specific gravity =2.64
- Fineness Modulus = 6.816

e) Water

Water is an important ingredient of concrete as it actively participates in the chemical reaction with cement. Since it helps to form the strength giving cement gel, the quantity and quality of water is required to be looked into very carefully. Mixing water should not contain undesirable organic substances or inorganic constituents in excessive proportions. In this project clean potable water is used.

III. Mix Design for M-20 Grade Concrete

a) Design Stipulations

- Characteristic Compressive Strength required at the end of 28 days: 20 N/mm^2
- Maximum size of Aggregate: 20mm (Angular)
- Type of Exposure: Moderate
- Degree of Quality Control: Good

b) Test Data for Materials

- Specific Gravity of Cement: 3.15
- Specific Gravity of Coarse Aggregate: 2.64
- Specific Gravity of Fine Aggregate: 2.70

c) Target Mean Strength of Concrete

For a tolerance factor of 1.65, the obtained target mean strength for the given grade of concrete = 27.6 N/mm^2.

d) Selection of Water Cement Ratio

The free water cement ratio for the obtained target mean strength is 0.50. This is equal to the value prescribed for Moderate conditions in IS 456.

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Table 5 : The mix proportion

Water	Cement	Fine aggregate	Coarse Aggregate
0.5	1.0	1.5	3.0
210kg	420kg	630kg	1260kg

Note-In this experiment, we prepared 6 test specimens of control concrete & 10%, 15%, & 20% fine aggregate replaced by saw dust by volume each.

Table 6 : The results of the compressive strength of saw dust Concrete-

	Age (Days)	Control Concrete	Percentage Replacement with Saw Dust		
			10%	15%	20%
Average Compressive strength (N/mm^2)	7	18.59	22.66	21.48	19.62
	14	20.59	18.15	18.30	20.50

Table 7 : Strength at 7 and 14 days with respect to % replacement of saw dust-

	Ages (Days)	Percentage Replacement with saw dust		
		10%	15%	20%
Increase(+) or decrease (-) strength %	7	21.89	15.54	5.54
	14	-11.85	-11.12	-0.437

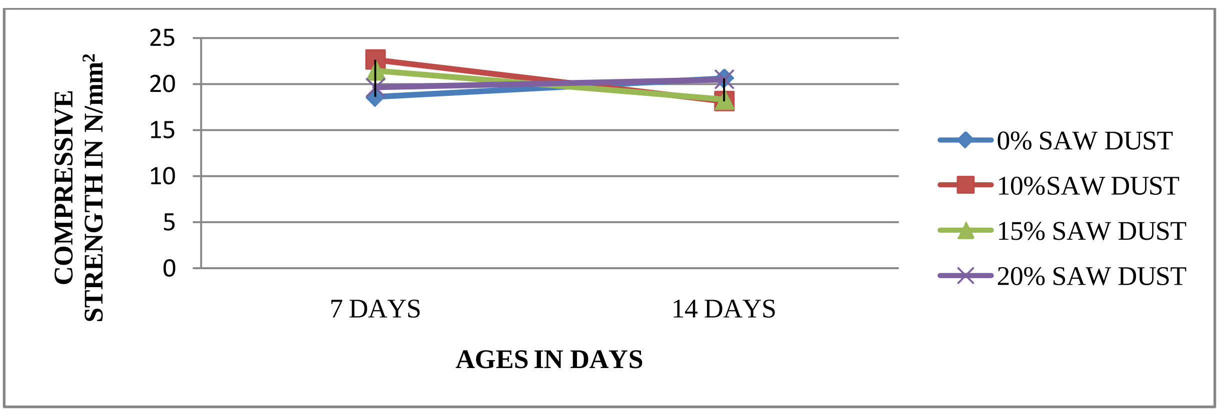

Figure 2 : Variation of Compressive strength with age and percentage of saw dust

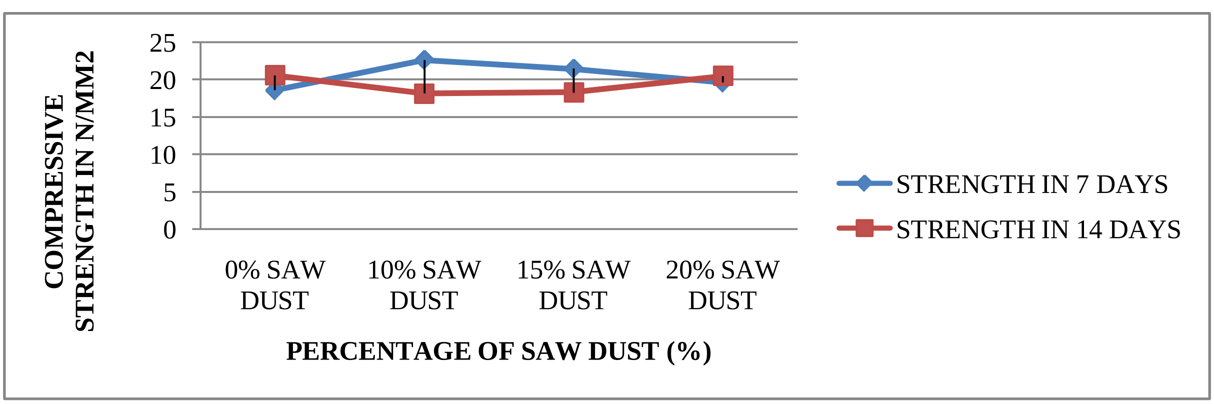

Figure 3 : Percentage of saw dust v/s Compressive strength

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IV. Conclusion

Based on the limited study carried out on the strength behaviour of saw dust the following conclusions are drawn:

- At the initial ages, with the increase in the percentage replacement of saw dust, the strength as well as compressive strength increases.
- Moreover with the use of saw dust, the weight of concrete reduces, thus making the concrete lighter which can be used as a light weight construction material in many civil engineering purposes.

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Socio-Hydrological Vulnerability: A New Science through Remote Sensing and GIS

By Mukesh Singh Boori & Vit Voženílek
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Abstract- Socio-hydrological vulnerability is a new area of research that integrates people and their activities into water science. This type of research is important in water scare areas such as arid and semi-arid areas on the globe. The main objective of this type of research is to develop a socio-hydrological vulnerability index in semi-arid region by combining remote sensing, bio-geophysical and social data. In general, vulnerability is expressed as a function of the exposure, sensitivity and adaptive capacity of a region to natural disasters and climate change effects. The heart of water security is the ability of water systems to meet changing human and environmental needs. Socio-hydrological vulnerability research ensures that decisions made about our water resources incorporate a range of values and perspectives about the meaning, value and use of water. Presently scientists bring an interest in human values, markets, social organizations and political institutions to the traditional focus of water science on climate, social and hydrology. It is a reality that natural disasters (such as drought and floods) results in sets of socio-hydrological impacts starting with crop-yield failure, unemployment, erosion of assets, income decrease, poor nutrition and decreasing risk absorptive capacity, thereby increasing the vulnerability of the community. In addition, it is demonstrated that the severity of these social impacts is experienced differently and depends one hand on socio-hydrological characteristics and on other hand on people's exposure and characteristics, which are respectively named bio-geophysical, hydrology and social vulnerability. Mapping socio-hydrological vulnerability patterns across space and time helps to identify socially and bio-geophysical vulnerable areas and assists with climate change adaptation strategies in areas to projected socio-hydrological vulnerability.

Keywords: remote sensing, GIS, socio-hydrological vulnerability.

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I. A New Scientific Approach

Natural disasters and climate change is a global phenomenon which can be adopted and mitigated only through the unified action of the people across the globe. The issue surrounding climate change and its impacts human health, patterns and the intensity of the precipitation, water and the food supplies, energy supplies and the viability of the natural system will be affected as the earth's climate continues to change [1]. Many of these changes are the irreversible and will shape generations to come. It is therefore vital to engage and mobilize today's young minds to create innovative and the multidisciplinary answers to the many potential problems, to bring them together and promote productive and the informative discussion and to share each other's thoughts, foster ideas and the establish connections can also be the best seen as interactions and the learning between generations each learning from the one another [2]. This type of research work consider semi-arid region, which is experiencing a reduction of water availability due to changes in the climate [3] as well as increase in human water demand for urban supply, irrigation, and other purposes. As such, these regions are broadly representative of water-scarce regions globally those are facing increasing threats to water security [4].

One of the most important impacts of natural disasters and climate change occurs in water resources availability. Surface water and groundwater recharge may be directly affected by change in rainfall and increase in air temperature that causes higher evapotranspiration rates [5]. A direct consequence of changes in stream flow regime is the impact on water supplies. This is expected to lead to decreased water quantity available for different uses, especially to guarantee food supply for population in the arid and semi-arid tropics [6]. Natural disasters and climate change may also affect the function and operation of existing water infrastructure as well as water management practices [7]. Conversely, adaptive water management through forward-looking planning and operation of infrastructure coupled with flexible demand management represent important strategies to face climate change and variability [8]. Social impacts refer to all changes in the way *people* live, work, related and organize. (Inter-organizational Committee on Guidelines and Principles for SIA 1998) More concrete, social impacts concern poverty, loss of life, health effects, loss of community cohesion, loss of time, changing attitudes, impoverished neighborhood, etc… But social impacts are difficult to quantify in monetary terms and are often not estimated ex-ante [9]. However, several studies, like the wide impact-survey in Scotland and the survey on natural disasters experience in Belgium, have concluded that natural disaster victims experience intangible impacts as being even more severe than tangible impacts [10].

Understanding the concept of socio-hydrological vulnerability, its extent, mapping,

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formulating vulnerability functions enabling risk impact assessments and the gravity of its dynamics at the levels of significance are needed before natural disasters management planning can be put into action [11]. These exercises will aid in recognizing, prioritizing, planning and channeling the resources to improve the capacity to adapt [12]. Furthermore, the existing constraints in financing the adaptation apply equally to all regions. So prioritizing, the regions need special attention and one should take into account the socio-hydrological vulnerability and impacts caused by climate change and natural disasters (drought and flood).

Socio-hydrological vulnerability research will give a brief of the existing approaches that focus on socio-hydrology and impact assessment aid to characterize and identify regions, sectors and communities which are at risk for socio-hydrological vulnerability currently and in the future [13]. It will also discuss the limitation, constraints and pre-requisites in these approaches and highlights the importance of micro level information to have a more realistic understanding of impact and socio-hydrological vulnerability through illustration. Socio-hydrological vulnerability will provide a guiding framework for devising action plans to improve adaptive capacity among vulnerable populations. For this type of research, the socio-hydrological vulnerability index incorporated not only the frequency and intensity of hazard events such as floods, drought conditions, and natural disasters, but also the gradual changes in mean temperature and precipitation. Socio-hydrological vulnerability research will estimate the natural resources of the study area and will be effective for evaluating natural resource mapping and their proper management for future utilization. This type of research work will entails the maximum utilization of existing natural resources to reduce regional imbalances, promote sustainable development and at the same time ensure the protection of fragile eco-environment [14].

II. Embryonic Vigorous Importance for Human-Water System

The main aim of socio-hydrological vulnerability research must be detect the spatial and temporal patterns of socio-hydrological vulnerability due to land use/cover, hydrology and socio-economic changes and to get a deeper insight in the mechanisms of these changes and to contribute to the ongoing debate about the causes and consequences or actual regional condition in arid and semi-arid regions by:

i. Build relationships with stakeholder communities to develop a common understanding of their values and what they identify as threats to water security,
ii. Collecting reliable data on vegetation degradation, deforestation rates, encroachment of agricultural land, silt deposition in river, flooding, droughts and patterns in the different landscape settings,
iii. Understand divergent perspectives on the definition of socio-hydrological vulnerability and the major driving forces for future insecurity,
iv. Create a spatial and non-spatial temporal data base of geo-environmental units, soil, slop, surface water bodies, drainage system and non-spatial like demographic data, occupation data and data related to amenities and general facilities, land and power availability (socio-hydrology) etc.
v. Assess the social and natural science questions deemed important by stakeholder communities and draw on local knowledge to inform the research,
vi. Identify problem and demands of the inhabitants and also distinguish and prioritize the factors that influence development of systems related to socio-hydrological vulnerability,
vii. Study societal response to water stress and to economic and policy instruments for socio-hydrological vulnerability,
viii. Determine the sustainability of these systems through indicators of economic, social and hydrology,
ix. Inform policy options to address water uncertainty and impediments to effective water governance,
x. Analyzing the drivers and mechanisms of land cover change with ecosystem and there effect on socio-hydrological vulnerability,
xi. Socio-hydrological vulnerability distribution and its dynamic change and cause of its levels,
xii. The development of future land use scenario's based on typical pathways of changes.

The focus of socio-hydrology is on observing, understanding and predicting future trajectories of co-evolution of coupled human-water systems. In this sense, one could say that socio-hydrology is the fundamental science. Could we predict this? What will be the role of hydrology in any changes in the landscape including societal changes, and in return, what will be the impact of the societal changes on water cycle dynamics? Should such predictions be the business of hydrologists or social scientists? [15].

III. Socio-Hydrology: The Way for World

Arid and semi-arid regions such as North America, Northeast Brazil, Sahel Africa, Central-eastern Iran, North-west India and Central Australia are interesting because of the change in vegetation cover from dense vegetation to very little or no vegetation as desert area. In these areas living standard are highly variable due to different types of socio-economic activities. There are different types of soil, vegetation cover, climate and relief along its extension. In these areas, many families live in the interior without access to

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water for drinking, cooking and hygiene. These families live far from the systems of water supply. During periods of severe droughts, these populations are supplied with water by tanker trucks and, in some cases, collecting water from springs and small reservoirs in daily journeys, generally made by women and children. In addition to this, wells and cisterns are the more common water collection and storage systems in these regions [15].

NASA climate and land cover datasets are useful to advance the climate change portion of the socio-hydrological vulnerability assessment. Specifically, changes in temperature and precipitation can measure using monthly NASA's Modern-Era Retrospective Analysis for Research and Applications (MERRA) and Tropical Rainfall Measuring Mission (TRMM) 3B43 datasets, respectively. The satellite data can compare with the weather station data from the Department of Hydrology and Meteorology in these regions. The socio-economic data can obtain from the Statistics departments to measure the social vulnerability of the population. Historical records of climatic disaster events can acquire from Disaster Information offices to measure exposure to climatic disasters. Land cover maps such as Landsat 7 can useful to identify high-density urban areas prone to the urban heat island effect, and areas prone to landslides and natural disasters.

Fig. 1 : Arid and semi-arid region on globe

The datasets should obtain and reviewed with literature review for quality and completeness. Indicators should define as a variable that quantifies and characterizes the level of vulnerability or resilience in these areas. The index must be a consequently composite of the indicators that summarizes overall vulnerability to natural disasters, social factors, hydrological and climate impacts. This type of research work must be focus on data analysis and model building in order to develop the socio-hydrological vulnerability index by following stapes:

- *Literature study and compilation of past and present-day land cover maps for Socio-hydrological vulnerability evaluation using visible and microwave remote sensing multi-temporal and multispectral satellite imagery.*
- *Collection of socio-economic, population, environmental and hydrological data for socio-hydrological vulnerability estimation. Also comprehension of the mechanism of socio-hydrological vulnerability – influencing parameters, special attention on biomass, hydrology and social communities.*
- *Identification of the main socio-economic, bio-geophysical and socio-hydrological drivers for land*
- *use change with ecosystem and there effect on socio-hydrological vulnerability.*
- *And in last develop future socio-hydrological vulnaribility scenarios and evaluation of possible management strategies.*

Medium and high resolution multispectral satellite imagery (ASTER, AMSR-E, LANDSAT, IRS and SPOT) must be used to compile land cover maps for these areas. The developed spectral signatures should be used to identify upland fields, forest, scrubland, rangeland, surface water body, potential ground water zone, and degraded areas [16]. For calculating socio-hydrological vulnerability, at least fifteen factors such as elevation, slope, accumulated temperature, flood index, drought index, land use, vegetation, soil, geology, geomorphology, water-soil erosion, socio-economic activities, population density etc. must be use. Reference data for ground calibration and validation would be collect by means of GPS-measurements in representative landscape types. Additional land cover data from available aerial photographs and topographic maps are useful to calibrate and validate the classification procedures in small test areas. These results will allow analyzing the spatial and temporal patterns of land cover and socio-hydrological vulnerability change in these regions.

Table 1 : Possible components and indicators which, useful for the vulnerability index

Component	Indicator
Exposure	Deaths per 100,000 inhabitants (climate-related disasters)
	Losses per GDP in % (climate-related disasters)
	Number of droughts
	Number of floods
	Number of storms
Sensitivity	Land cover
	Forest cover
	Rain-fed agriculture
	Cereal yield (crop production)
Adaptive capacity	Water access (rural)
	Water access (urban)
	Paved roads
	Governance
	Population growth rate
	Population below poverty line
	Vulnerable employment
	Rural population

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A balanced weight approach [17] must be used in this index, assuming that each component contributes equally to the index, regardless of the number of indicators under each component. To do this, the component score must be divided by the number of indicators. The weight scheme can be adjust to reflect the perceived importance of specific factors. The application of subjective weighting on the one hand give us some indication of how the relative importance of different factors might vary with context and can also tell us how sensitive socio-hydrological vulnerability ratings will to perception of vulnerability in the expert community. Alos follow on following basic factors, which are affect on study area vulnerability:

a) *Natural Impact*

i. Climatic impact: drought index, rain fall, wind, temperature,

ii. Topographic impact: slope, elevation,

iii. Physical impact: geology, geomorphology, soil, vegetation, land use/cover, hydrology,

b) Environmental impact: hazards, surface and ground water, water-soil erosion, atmospheric composition, biogeography and biodiversity,

c) Human impact: road density, population density, socio-economic characteristics.

Indicators must be select based on the statistical analysis. Multiple indicators should select to represent each of the three major components of socio-hydrological vulnerability (exposure, sensitivity and adaptive capacity). If no statistically significant relationship could be ascertained between a candidate indicator and socio-hydrology, the indicator must remove from consideration. The indicators should also taste for autocorrelation. Further, selected indicators use to calculate the socio-hydrological vulnerability index as outlined below. The results of the calculation will map on a Geographic Information System (ArcMap) to determine the geographical distribution of socio-hydrological vulnerability; the results should subsequently compare with statistical results at the global level.

Each indicator should measure on a different scale (or different units), so it`s necessary to standardize them. In order to carry out the conversion, the values should index and represent as a percentage of the maximum for that indicator:

$$Indicator_{standardised} = \frac{Indicater_{value}}{Indicator_{maximum}}$$

Subsequently the indicator values add to obtain the value of the component:

$$Component\ value = \frac{Indicator_1 + Indicator_2 + \cdots \ldots\ldots + Indicator_n}{n}$$

Where n is the number of indicators for a particular component.

Component value should similarly normalize, such that the maximum value for each should 1. The resulting normalize values would then multiply to obtain the index score:

$$Vulnerability\ score = Expoure_{value}\ \text{X}\ \text{Adaptive capacity}_{value}$$

The index score should also normalize with 1 being the maximum value. The results of the calculation should use to express relative socio-hydrological vulnerability. Values associated with the model would divide into five different categories using the quintile method, with each range cumulatively representing 20% of the maximum vulnerability.

IV. Conclusion

The relevance of natural disasters such as droughts, floods and its impacts is well recognized. Socio-hydrological vulnerability studies have shown that the tropics of South America, Africa, Asia and Australia could experience a significant change in the frequency of occurrence and the intensity of natural disasters [10] and they have a multidimensional effect on humanity in terms of several socio-economic parameters like agriculture, human health, sea level rise, scarcity of labor, disease prevalence, etc. Natural disasters are expected to impact livelihood and their occurrence will further aggravate poverty levels and sustainability of livelihood means in the years to come. The adversities resulting from natural disasters emphasize the importance of strategies needed to cope with the impacts. Unless well-thought strategies are implemented, they can result in a far reaching consequence and cause severe impacts on societies and livelihood especially among the natural resource dependent communities [18]. Managing socio-hydrological vulnerability and enhancing resilience against natural disasters are the major pressing issues particularly among the developing tropical countries of the continents. However, the impacts, socio-hydrological vulnerability and capacity to adapt to these changes differ with time and space [19]. For the same reason, international and national organizations, viz., United Nations Frame work Convention on Climate Change (UNFCCC), World Meteorological Organization (WMO), United Nations Convention to Combat Desertification (UNCCD), etc., are partnered to formalize plans to minimize the impacts.

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Health Post a Sustainable Prototype for the Third World

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Abstract- This paper concerns the study of sustainable construction materials applied on the "Health Post", a prototype for the primary health care situated in alienated areas of the world. It's suitable for social and climatic Sub- Saharan context; however, it could be moved in other countries of the world with similar urgent needs. The idea is to create a Health Post with local construction materials that have a low environmental impact and promote the local workforce allowing reuse of traditional building techniques lowering production costs and transport. The aim of Primary Health Care Centre is to be a flexible and expandable structure identifying a modular form that can be repeated several times to expand its existing functions. In this way it could be not only a health care centre but also a socio-cultural facility.

Keywords: low costs building, sustainable construction materials, green construction system, prototype, health care, emergency.

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HEALTHPOSTASUSTAINABLEPROTOTYPEFORTHETHIRDWORLD

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Health Post a Sustainable Prototype for the Third World

Chizzoniti Domenico [α], Beggiora Klizia [σ], Cattani Letizia [ρ] & Moscatelli Monica [ω]

Abstract- This paper concerns the study of sustainable construction materials applied on the "Health Post", a prototype for the primary health care situated in alienated areas of the world. It's suitable for social and climatic Sub-Saharan context; however, it could be moved in other countries of the world with similar urgent needs. The idea is to create a Health Post with local construction materials that have a low environmental impact and promote the local workforce allowing reuse of traditional building techniques lowering production costs and transport. The aim of Primary Health Care Centre is to be a flexible and expandable structure identifying a modular form that can be repeated several times to expand its existing functions. In this way it could be not only a health care centre but also a socio-cultural facility.

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I. Introduction

The importance of right to health has been affirmed after being cited in the Universal Declaration of Human Rights and has been confirmed as a human right following with declaration of the 30th World Health Assembly, "Health for All by the Year 2000", in 1977.

The studies showed that most of the people of the third world countries primarily need health care interventions at a rather basic level. These basic interventions are gathered under the name of "Primary Health Care" (PHC) whose principles were definitely stated in the Declaration of Alma-Ata, which was held in the Soviet Union in 1978, following the International Conference sponsored by the World Health Organization (WHO) and UNICEF.

After the Alma-Ata declaration, the Harare Conference was held in 1987 developing the program of "Selective Primary Health Care" as a response to the difficult implementation of PHC.

These conferences were a response to growing expectations for a new public health movement around the world, and thanks to them the importance of Primary Health Care was underlined and it was provided as an integral part of a country's health care system.

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To implement the PHC systems the countries need to redirect their policies, strategies and resource allocation, and overcome the cultural and political barriers. As a result, they need to focus on rural areas and the most deprived urban ones, where the primary needs and pathologies of the poorest people are so diffused [1].

In most developing countries the health care has the task to increase in the community the awareness of the causes of disease. These may include domestic causes such as contaminated water, lack of services or sewerage, waste disposal, lack of attention to personal hygiene and preservation, processing and preparation of food.

Providing medical care can bring only limited progress if there isn't a program to improve housing conditions, prevention and health education. The health care in a developing country, particularly in rural areas, must carry out the task of education and leadership in the community.

Although health officials declare that their national priorities should be the improvement of hygienic conditions, infection control and primary health care in rural areas, much of their money seems to go always more frequently in major urban hospitals [2].

The role of PHC is different from that of the "district hospitals" since they don't function to lighten the burden of the main hospital, not because it is cheaper to have the first contact at the peripheral level, but because the patient, in a properly working system, is often better cared for at the primary level. The hospital is often overload with primary care work, so involvement of the hospital in primary care activities results in a lower quality of care, so there are tasks for which the health centre is better suited than the city hospital or the district hospital.

II. Locating the Health Centre

The location of a health care facility is chosen mainly on the basis of physical elements, it is necessary to consider factors like population density, water supply, sanitation and waste disposal and access to public transport. The zones with worst situations are those that should receive priority in interventions.

Cultural characteristics and resources of the population have to be considered in locating a health centre as well. Resources are not only money or

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materials but also technologies and people's skills. In the third world countries the health centre facilities usually face with financial problems due to the fact that they are often scattered in the country and have difficult links with the decisional centres. If the Health Centre can't connect properly with the population it will face with a quick obsolescence and low efficiency [3].

This implies that the centre should be planned considering different cultural factors and in such a way to be able to grow.

To induce people to approach the health care services, we must have ideas about their potentialities and how they can be involved in strategic planning proposals to increase outcomes.

To consider the most practicable location of health centers in rural context, we have to assume that a large number of people should reach the centre by foot. Therefore it is really important that health centers are within easy reach and that they work mainly with outpatients.

III. Health Post Strategy

The health service of a country in the developing world, particularly in rural areas, must accomplish the task of education and leadership in the community. It's certain that the more efficiently it will perform its duties in diagnosis and treatment, the sooner the community to which it addresses will evolve.

The cooperation between community and health post could increase the quality of life of rural communities. The attention must be focused on *community development* rather than considering individuals, favoring a substantial increase in the number of health care in the villages and health centers linked to larger hospitals.

In rural areas, the first unit of medical care should be represented by one person for each village. The main activity is the midwife of the place, equipped with some drugs, and it has the task of imparting the rudiments of hygiene and basic medical care.

The dimension of Health Post depends on the conditions of life of the community and its particular needs, the prevalence of specific diseases and socio-cultural conditions. The unit-base must be designed for future *expansion*, and should provide some *flexibility* to change the intended use and to vary the number of beds for men and women.

Independently from the dimension of the structure, the Health Post will be managed by fewer staff than the health centres, and there will be a minor specialization of tasks.

The Health Post must be regarded as the first element of a larger unit because in the future may need to expand it, especially if the project is implemented within a regional or national health plan. At the beginning the construction could consist of little more than a room for medical examination and treatment (examination of blood, urine and stool sample is needed for identification of most common parasites in blood and for doing simple tests for common illnesses) with an outdoor waiting area form by a covered veranda. Essential is a space for the protection of the drugs. Drug storing, preparation and delivery need a secure and visually controllable space. It can also work as a little pharmacy in the more developed PHC Centres. However, it's best to prepare a small service room in the centre, so that the department is divided into separate sections for men and women. Dividing the space into smaller compartments involves greater flexibility of use. The rooms of the services are reduced to the essentials and the *restrooms* will be separated for the two sexes, but all concentrated in the same place.

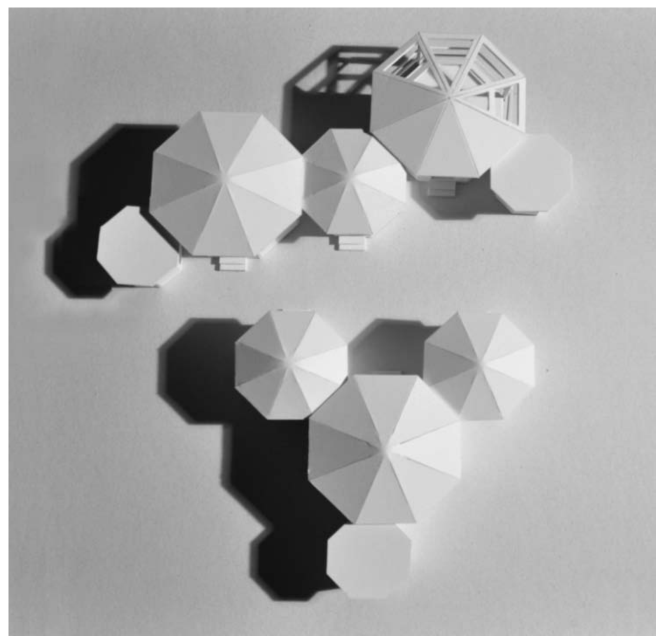

Fig. 1 : View of the cardboard model (1:100)

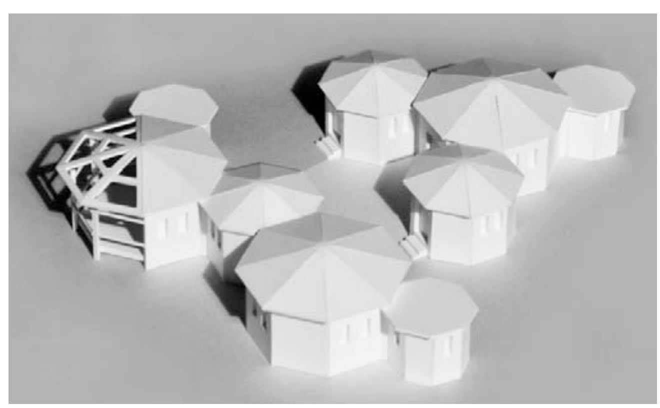

Fig. 2 : View of the cardboard model (1:100)

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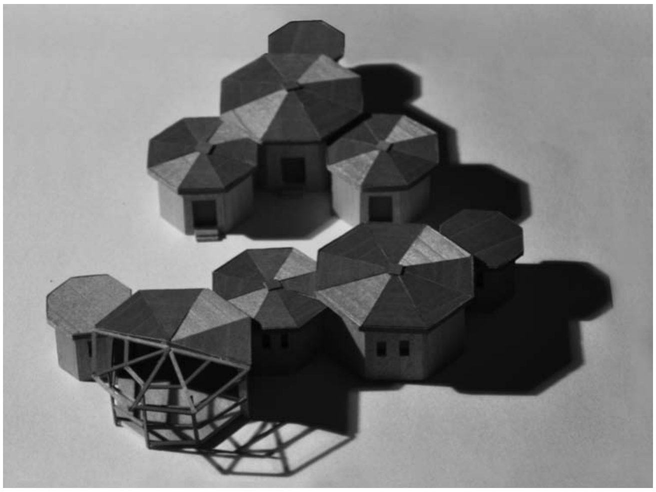

Fig. 3 : View of the wood model (1:100)

In focusing on sewage disposal systems as the basic support service to be provided in a health care facility, it's very important to notice that the choice of the system (waterborne, pit latrine, etc.) has to be made versus the broad characteristics of a tropical country. These may be summarized in a scarcity of clean water, difficulties in transportation and a climatic situation marked by heat and humidity which create ideal conditions for pathogen survival.

In rural areas, it is likely that patients arrive on foot, sometimes with their families. If the treatment involves several visits, it is unlikely that they will return home, but will seek shelter near the medical center. The admission often means that other relatives are present and play a very important role: for example, the shelter of a child involves the presence of the mother. In this regard, there are examples where this crowd is controlled with the construction of a village or simple hostels near the health center. These accommodations can also be used by not contagious self-sufficient patients.

IV. Sustainable Construction Materials

One of the main principles of the Health Post is the cultural, environmental and economic sustainability.

The choice of construction materials is different and depends on the climatic conditions of the place, but it is important to use materials that can be adapted to all types of temperature and humidity, such as wood, terracotta and brick. However it is necessary to refer to *local material* to involve local workers in construction site, who have knowledge of traditional building techniques related to materials characteristic of the area [4].

The wood and the materials of vegetable origin are the most used and usable indifferently on the local climatic conditions, because they are almost always available on-site and ensure an efficient thermal insulation. Furthermore they have a low environmental impact, are accepted by the local population, promote labor allowing the reuse of traditional building techniques and lowers costs of production and transport.

In PHC the dimensions and environmental characteristics should be defined for each homogeneous spatial field. Building materials, parts and technical solutions are based on ambient characteristics [5]. These solutions can help to filter the outdoor climate as to create a new climate for human well being. Materials and technologies play an important role on the quality of the building, on its comfort level and privacy. In order to choose the appropriate materials, the performance specifications such as acoustic privacy or hygienic characteristics must be defined for each comfort level. For this reason it is important to define the requisites of material which have to be used in order to set the characteristics of the building elements which allow the performance of sanitary activities in a comfortable way. Traditionally such requisites have been drawn up as series of standards to be met by the designer. Concerning comfort needs, materials play an important role in regulating factors such as air temperature, radiation and air movements.

The main parameters on which the materials can be chosen are absorbency / emissivity, porosity, insulation value and thermal capacity or heat storage value.

Fig. 4 : View of the project

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Fig. 5 : View of the project

Fig. 6 : View of the project

Health facilities in emergency situations can be designed with different technologies; it would be better to have *hybrid structures* characterized by traditional technologies [6]. These local technologies' performance could be improved through the use of innovative materials mainly imported. It is not necessary to use the latest materials, but simply combine human labor and equipment. Consequently the local manpower does not require a high degree of specialization, reducing construction costs and obtaining the realization times faster. It's essential to consider these devices to allow greater simplicity of the technology to be used and thus reduce the negative aspects related to the construction of a new building, such as excessive consumption of the territory, waste of energy, emission and dispersion of pollutants, production of waste.

On the other way, it is not undervaluing the *didactic nature that the construction site assumes* in these areas: it becomes the place of acquisition and transmission of, technical and theoretical construction knowledge, in which practical skills are the basis of the building.

The fundamental characteristic aspects of great construction are: the reaching of *environmental objectives*, the implementation of compatible solutions and the use of available resources. These concepts must be kept in mind especially during the design of external walls and their structural equipment.

V. A Wooden Prototype

The idea is to create a prototype of a medical facility to be placed in the Third World countries, giving special attention to Africa. The prototype designed is inspired by the gabled structure. The hut is the type of Africa traditional housing, built with *raw materials* [7].

The Health Post is composed by wood frame structure. The wood has been used not only for the frame of the building, but also especially for the roofing structure covered by fully recyclable metal coverage. Energy-efficient due to the fact it reflects the sun's rays and keeps fresh the structure during the hot summer months. In general metal roofs weight very little and can sometimes even be installed over temporary roofing systems.

The gabled structure becomes the core of the prototype and collects inside the different functions of the health facilities.

The *modular system* for the health centre has many advantages. First of all it facilitates the design process and gives the project an interesting architectural quality, since the whole structure is going to be based on one single module changing functions. The aim is to create other structures for different function that are not only for health, but also public spaces with different community services [8].

The project is a way to produce a central plan, using basic elements like sets to create different spaces. It's a simple intersection of hexagonal shapes with different dimensions linked to each other in various arrangements.

The project involves the wooden floor, raised forty centimeters from the ground in order to avoid flooding and soil infiltration. Each hexagon represents a cell that can be isolated from the others by a door placed in an intermediating position between the sides of the structure.

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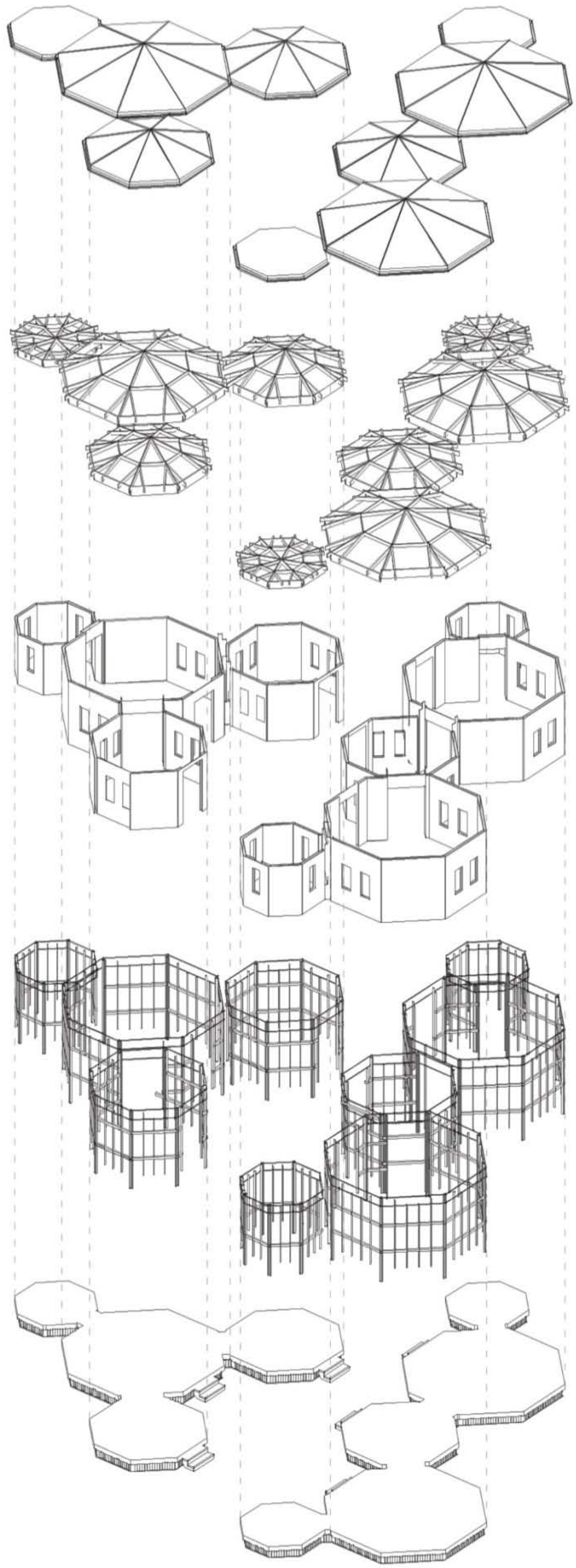

Fig. 7 : Exploded axonometric view

The small rooms can be used for support functions like medical facilities, drugs and water storage, tanks. The largest rooms can host function related to the care for treatment or clinical rooms. All the reception or waiting areas are outside of the structures according to the idea to produce these structures with few resources.

Under conditions of limited resources, the possibilities for service rotation are the best way to provide in the same space different services in different days of the week. In this way is possible to reduce the total required surface for the facility and the construction costs. The interchange of services into one space means that rooms must be planned in a flexible way on average dimensions and with adaptable arrangement of outfitting.

Flexibility has three aspects, which are also the aspects that the PHC Centre should have:

- the rooms should be planned on the basis of activities performed in them to avoid discomfort. It will be necessary to accommodate in a given room compatible sets of activities, this aspect of flexibility is called *versatility*.
- if this substitution of activities becomes permanent it's called *convertibility*, which implies that some adaptations of building parts are possible and easy.
- if a facility is able to grow with an increasing demand, it's called *expansibility*. Expansibility is one of the most important characteristics that a PHC Centre should have, by enlarging it can gain more functions and therefore more importance in the zone where it will exist.

The idea is to find a module that must be easily repeatable for a future expansion. Following the idea to enhance the Health Post, it is necessary to consider first of all the location in order to facilitate the supplying system (energy and water). The nodal point should be located in a rational way, in order to have sufficient growth [9].

Particular attention is given to the open spaces as much as inside, considering that the outdoor spaces could be dedicated to common activities and could form a comfortable space for people.

The aim is to create a prototype that could be used in the whole African continent. This prototype, which is interpreted as a module has to be easily adaptable in different countries, changing simple characteristic elements and materials based on the local supplies.

VI. Conclusion

This project has the aim to emphasize the importance of social sustainability, understood as the ability to ensure conditions of human well-being, through sustainable building that is able to guarantee at the same time the protection and renewal of natural resources and of the environmental heritage of the place.

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The design approach for a PHC center should have a goal far more extensive than that relating only to health care as the construction will be the engine for a new conception of "social structure" [10].

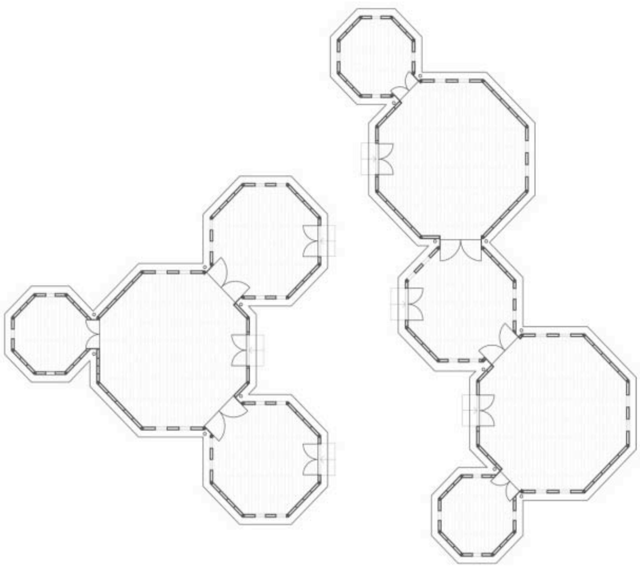

Fig. 8 : Ground floor plan: intersection of hexagonal shapes

Fig. 9 : Health Post: sections

Fig. 10 : Health Post: facades

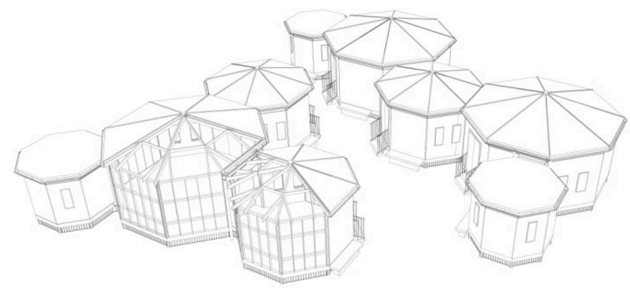

Fig. 11 : 3D model: future expansion

The intention of the project was therefore to go beyond the health centre, creating a space structured by social relations and placing the patient in the active position with respect to the context.

It is an important goal of the project to search the quality of the environment, because the quality of construction permits, together with the improvement of the wellbeing of the population, to arouse greater interest in the architectural and environmental aspects.

Africa is a continent hungry for growth, development, modernity. It's necessary to find modern *solutions that are sustainable,* not only from an environmental perspective but also from the cultural one. It's better to let local workers participate on the construction, and teach them how to build an efficient structure (educational aspect of the construction site), rather than using modern machinery, that reduce construction time, but are very expensive and do not allow them to learn new construction techniques. It's also demonstrated that a structure built by able and willing local workers is more efficient than a structure imported and built with modern machinery.

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Removal of Malachite Green and Crystal Violet Dyes from Aqueous Solution with Bio-Materials: A Review

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Abstract- Malachite Green and Crystal violet are among millions of dyes which are being used in every aspect of day to day life of a human being. Approximately 12% of synthetic dyes are lost during manufacturing and processing operations and 20% of the resultant color enters the environment through effluents from industrial wastewater. They are toxic and having extremely harmful consequences; hence many governmental and environmental agencies have put in place very strict regulation and restriction on discharge of industrial waste water/effluent containing dyes into the natural water bodies. There are various technique available for removal of dyes from waste water but adsorption is the process of choice. Activated carbon is the best known adsorbent. But its use in treating the industrial waste water especially in developing countries is restricted due to very high cost. This high cost of activated carbon has forced the researchers to find out low cost and effective adsorbent which may be used as an efficient alternative of activated carbon. In this paper an attempt has been made to compile the work of various researchers on removal of crystal violet and malachite green dyes from aqueous solution by using biomaterials and agricultural waste during the last five years.

Keywords: malachite green, crystal violet, dyes, toxic, biomaterials.

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REMOVALOFMALACHITEGREENANDCRYSTALVIOLETDYESFROMAQUEOUSSOLUTIONWITHBIOMATERIALSAREVIEW

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Removal of Malachite Green and Crystal Violet Dyes from Aqueous Solution with Bio-Materials: A Review

Binod Kumar [α] & Upendra Kumar [σ]

Abstract- Malachite Green and Crystal violet are among millions of dyes which are being used in every aspect of day to day life of a human being. Approximately 12% of synthetic dyes are lost during manufacturing and processing operations and 20% of the resultant color enters the environment through effluents from industrial wastewater. They are toxic and having extremely harmful consequences; hence many governmental and environmental agencies have put in place very strict regulation and restriction on discharge of industrial waste water/effluent containing dyes into the natural water bodies. There are various technique available for removal of dyes from waste water but adsorption is the process of choice. Activated carbon is the best known adsorbent. But its use in treating the industrial waste water especially in developing countries is restricted due to very high cost. This high cost of activated carbon has forced the researchers to find out low cost and effective adsorbent which may be used as an efficient alternative of activated carbon. In this paper an attempt has been made to compile the work of various researchers on removal of crystal violet and malachite green dyes from aqueous solution by using biomaterials and agricultural waste during the last five years.

Keywords: malachite green, crystal violet, dyes, toxic, biomaterials.

I. Introduction

Dyes in different form are being used in every aspect of day to day life of a human being. At present there are more than 1,00,000 Commercial dyes with rough estimates of production range between $7x10^5$ tons to $1x10^6$ tons per year[1] Among them Crystal Violet and malachite green are one of the widely used synthetic and cationic dyes. The molecular formula of crystal violet and malachite green are $C_{25}N_3H_{30}Cl$ and $C_{23}N_2H_{25}Cl$, the molecular mass are 407.979 g mol^{-1} and 364.91 g mol^{-1} and melting point are 205 °C and159 °C respectively. Both the dyes are soluble in Water and Alcohol. They are Stable, Incompatible with strong oxidizing agents, strong acids, Light-sensitive and Combustible [2]. Color Index Number (CI) of crystal violet and malachite green are 42555 and 42000 respectively. When crystal violet is dissolved in water the dye has a blue-violet colour with an absorbance maximum at 590 nm. Similarly when malachite green is dissolved in water the dye has a green colour with an absorbance maximum at 617 nm. Both the dyes are extensively used as a dye in paper and pulp industries, leather industries, and textile industries. They are also widely used for various medicinal purposes like as a biological stain for microscopic analysis of cell biology and tissue samples. Approximately 12% of synthetic dyes are lost during manufacturing and processing operations and 20% of the resultant color enters the environment through effluents from industrial wastewater [3].The presence of very small amounts of dyes in water (less than 1 ppm for some dyes) is highly visible and undesirable on aesthetic ground. [4]. It also interferes with transmission of light and upset the biological metabolism process which causes the destruction of aquatic communities present in Eco-system. Further, dye has the tendency to sequester metal and may cause micro toxicity to fish and other organism. Due to these harmful consequences many countries have put in place very stringent regulation. Due to enforcement of very stringent regulation by the various environmental and governmental agencies upon the industries ,the interest of researcher have moved towards to find the cost effective methods for removal of dyes from aqueous solution. The waste water containing dye(s) is difficult to treat since the dyes are very complex organic molecule, resistance to aerobic digestion and are stable to light, heat and oxidizing agents. [5]. during the past three decades, several physical, chemical and biological decolourization processes have been reported. They are Coagulation, Flocculation, Biodegradation, Adsorption on activated carbons, Membrane separations, Ion-exchange, Oxidation, Advanced oxidation process, Biomass, Selective biosorbents. However, these methods have several disadvantages that include incomplete dyes removal, high reagent and energy requirements and generation of toxic sludge or other waste products that requires proper disposal and further treatment. These methods are very costly, making them uneconomical and unviable. Amongst the numerous techniques of dye removal, adsorption is the procedure of choice and gives the best results. [6] Commercially Activated carbon adsorption has been cited as one of

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the best dyes control technology by the US Environmental protection Agency [7]. The very high capacity of Commercially Activated carbon for removal of dye through adsorption is mainly due to their structural characteristics and their porous texture which gives them a large surface area, and their chemical nature which can be easily modified by chemical treatment in order to increase their properties. However, activated carbon presents several disadvantages. It is quite expensive, the higher the quality, the greater the cost, non-selective and ineffective against disperse and vat dyes. The regeneration of saturated carbon is also expensive, not straightforward, and results in loss of the adsorbent [8]. Due to the problems mentioned above, research interest into the production of alternative sorbents to replace the costly activated carbon has intensified in recent years. Attention has focused on various natural solid supports, which are able to remove pollutants from contaminated water at low cost. Cost is actually an important parameter for comparing the adsorbent materials. According to Bailey et al. (1999) [10] a sorbent can be considered low-cost if it requires little processing cost, is abundant in nature or is a by-product or waste material from another industry. Recently attention has been diverted towards the biomaterials which are byproducts or the wastes from large scale industrial operations and agricultural waste materials. The major advantages of biosorption over conventional treatment methods are: low cost, high efficiency, minimization of chemical or biological sludge, requirement of additional nutrient, and regeneration of biosorbents, and possibility of dyes recovery. Presently, agricultural waste materials have been proposed as economic and eco-friendly adsorbents. Agricultural materials are particularly those containing cellulose which shows a high potential in dye biosorption capacity. The adsorption process of dyes presently in aqueous solution by low-cost adsorbents from plant wastes can be carried with or without chemical modifications. Generally, chemically modified plant wastes are exhibiting the higher adsorption capacities than unmodified forms. More recently, the great efforts have been directed to develop a new adsorbent and improving the existing adsorbents to have an alternative to activated carbon.

In this paper an attempt has been made to compile the work of various researchers on removal of crystal violet and malachite green dyes from aqueous solution by using biomaterials and agricultural waste during the last five years.

II. Literature Review

On scanning the available literature on the subject matter it has been observed that researchers have investigated the effectiveness of biomaterials and agricultural wastes in removal of crystal violet and malachite green dyes from aqueous solution by adsorption in batch mode isotherm experiment. They have examined the effect of rotational speed of the shaker, pH value of the solution, contact time, initial concentration of dyes in the solution, dose of adsorbent, temperature of solution on the adsorption of dyes by biosorbents. Adsorption isotherm modeling, rate kinetic modeling, intra- particle diffusion analysis, thermodynamic analysis have been done by them on the experimentally observed data. Wang et al (2008) investigated the removal of malachite green from aqueous solution using agricultural by–products (wheat bran and rice bran). It was found that adsorption increases with increase in solution pH and attained equilibrium at 90 min. The equilibrium data of malachite green fitted better to Freundlich model. The kinetic data fitted better to pseudo-second order equation. While the external diffusion was the rate controlling step of the initial fast adsorption (< 15minutes) and in the next stage the intraparticle diffusion dominated the mass transfer. The thermodynamic analysis revealed that the adsorption of MG onto wheat bran and rice bran is spontaneous and favorable process [11]. Baseri et al (2012) investigated the adsorption of basic dyes (malachite green, crystal violet and rhodamine B) from synthetic textile effluent by activated carbon prepared from *Thevetia peruviana.* It was found that the amount of dye adsorbed increased with increasing initial dye concentration. The process was endothermic in nature. Kinetic studies showed that the adsorption of these dyes followed pseudo-second order model with multi-step intra particle diffusion model. The data obtained from adsorption isotherms are well fitted with Langmuir model, the negative ΔG^{O} value obtained suggested the process was spontaneous in nature [12].

Prasad et al (2012) studied the adsorption of cationic dyes (crystal violet and rhodamine B) from aqueous solution onto Acacia nilotica leaves as an eco-friendly adsorbent. The result showed that the optimum pH was 6 and the equilibrium time was 120 minutes. The removal efficiency increased with increase in agitation time and initial dye concentration. The equilibrium data were best described by Langmuir isotherm model with maximum monolayer capacity of 33 and 37 mgg-1 for crystal violet and rhodamine B respectively. The adsorption kinetics can be successfully fitted to pseudo–second order kinetic model. The result of the intraparticle diffusion model suggested that intraparticle diffusion might not be the only rate controlling step. Desorption study revealed that the recovery of the dye from adsorption was possible [13]. Tahir et al. [2009] investigated the removal of malachite green by using household used black tea as an adsorbent. The adsorbent was used in raw form and impregnated form. The equilibrium time of adsorption came out to be 10 minutes. Also, the data showed that there was decrease in the amount of the dyes

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adsorption with increase in temperature. The thermodynamic parameter showed that the process was exothermic and spontaneous. Furthermore, the result showed that the raw form of the adsorbent showed better adsorption capacity compared to its impregnated form [14]. Kumar et al. (2005) investigated the adsorption of malachite green onto Pithophora sp., fresh water algae. The algae were used raw and some were thermally activated at 300^{O}C for 50 minutes. The equilibrium data was very well represented by Redlich-Peterson isotherm. It was found that the thermally activated adsorbent possess a higher sorption capacity of 117.647mg/g than the raw one with 64.4mg/g. The kinetic data followed the pseudo-second order model closely and the negative value of Gibb's free energy change (ΔG◦) indicated that the sorption process was spontaneous [15]. Remenarova et al. [2009] studied the sorption of Malachite Green from aqueous solutions by moss Rhytidiadelphus squarrosus. The results showed that the equilibrium was reached within 1-2 hours. The equilibrium data best fitted the Freundlich isotherm model [16]. Uma et al.(2013) used Sawdust a timber waste as a bio-sorbent for the removal of a cationic dye, malachite green from aqueous solutions. Point zero charge (pHzpc) of raw sawdust was calculated by titrimetric method and that was 7.37. FTIR was performed to determine various functional groups attached to the adsorbent surface. The experimental results indicate that 5g/L g of sawdust was able to remove 93% of dye from an initial concentration of 20 mg/ L. Equilibrium was achieved in 100 min and the maximum adsorption of malachite green occurred in the higher (alkaline) pH range. The data was better fitted in Freundlich isotherm model. It was observed that dye removal decrease with increasing concentrations of dye solution. The maximum adsorption capacity of adsorbent was found to be 13.87 mgg−1 at 298 K. The dye adsorption followed the pseudo second- order kinetics. Removal process was endothermic in nature [17]. Jiao Li et al. (2013) investigated the removal of malachite green (MG) from aqueous solution using modified peanut shell (MPS). The SEM and FTIR showed that some components of raw peanut shell (RPS) had been removed during the chemical modification, and many cavities of various dimensions were clearly evident on the surface of MPS. Adsorption experiments showed that MG adsorption uptake was increased with an increase in initial concentration, contact time, solution temperature, and adsorbent dosage. Furthermore, neutral pH was optimum for the removal of MG. The adsorption of MG onto MPS agreed well with the nonlinear Langmuir and Sips isotherm models. The monolayer capacity (Q_{max}) was 32.73 or 35.85mg/g as calculated from Langmuir or Sips isotherm models, respectively. The adsorption kinetic studies showed that the adsorption process followed the pseudo-second-order kinetic model with a multi-step diffusion process [18]. Chen Z et al. (2014) used the Pleurotus ostreatus (a macro-fungus) as a new biosorbents to study the biosorption of hazardous malachite green (MG) from aqueous solutions. The equilibrium data best fitted with Freundlich isotherm model. The biosorption process followed the pseudo-second-order kinetic model. The Fourier transform infrared spectroscopy (FTIR) showed the presence of the functional groups such as, carboxyl, hydroxyl, amino and phosphonate groups on the biosorbents surface which could be the potential adsorption sites for MG biosorption [19].

Ashish S. Sartape et al. (2013) investigated successfully Wood apple shell (WAS) alternative adsorbent for the removal of hazardous dye malachite green. The removal of MG dye was found to be 98.87% with initial concentration 100 mg/L at pH 7–9 in 3.30 h by shaking at 150 rpm at 299 ± 2 K. The shifting of peaks in FTIR spectrum confirmed the MG dye adsorption onto WAS. The SEM study also made support to it by observing difference in surface morphology of adsorbent before and after adsorption of MG. The adsorption equilibrium data showed good fit to the Langmuir isotherm model as compared to the Freundlich isotherm model. The adsorption capacity for WAS was increased from 12.35 to 80.645 mg/g as the MG concentration in the test solution was increased from 100 to 700 mg/L. The adsorption kinetics followed pseudo first-order kinetic equation for sorption of MG onto WAS. Thermodynamic study demonstrates the spontaneous and endothermic nature of biosorption process due to negative values of free energy change ΔG◦ and positive value of enthalpy change ΔH◦, respectively. [20]

Mi-Hwa Baek et al. (2010) studied the degreased coffee beans as an adsorbent for removal of MG from aqueous solutions. The adsorption was highly dependent on initial dye concentration, temperature and pH. MG adsorption onto DCB reached almost equilibrium in about 4 h MG removal by RCB reached equilibrium in about 8h. The optimal pH was 10–12. The result of the present investigations showed that degreased coffee beans (DCB) have higher adsorption efficiency than raw coffee beans. The adsorbed amount of MG increased as initial MG concentration increase. The kinetic data best fitted the pseudo second-order kinetic model though the correlations coefficients from the pseudo first-order kinetic were as well relatively high for the range of concentrations studied. On the basis of Correlation coefficients (^{R2}) values it is revealed that the sorption of MG onto DCB followed both Freundlich and Langmuir models. Freundlich parameter, n value at equilibrium was 0.51, indicating a chemosorption adsorption of MG onto DCB. The maximum adsorption (monolayer) capacity of DCB for MG is 55.3 mg/gm at temp 2^{50}C. Thermodynamic studies showed that the adsorption processes were spontaneous and

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endothermic since ΔG◦ value was negative and ΔH◦ value was positive. In this study, activation energy ($_{Ea}$) = 78.5 kJ/mol for the adsorption of MG onto DCB, indicating the process as chemiosorption. [21]. Y.C. Sharma et al. (2009) investigated the activated carbon developed from rice husk for the removal of malachite green from aqueous solutions. Percentage removal of MG by RHAC increased with decrease in the initial concentration of dye. Time of equilibrium was found to be 40 min. The process of removal follows pseudo first order kinetics. Equilibrium studies were performed and the data fitted well in Langmuir and Freundlich adsorption isotherm equations. The n value was found greater than one (>1) at different temperature, indicating high intensity of adsorption of malachite green onto rice husk activated carbon. The maximum adsorption (monolayer) capacity of rice husk activated carbon for MG is 63.85 mg/gm at temp 30^{0}C. [22]

M. A. Ackacha et al. (2012) studied a new agriculture waste (Tamarix aphylla leaves) treated with sulfuric acid, sodium hydroxide and acetone as adsorbent for the removal of malachite green from aqueous solution in batch kinetic experiment. Tamarix aphylla leaves were first treated with sulphuric acid (0.225N H_2SO_4) then with sodium hydroxide (0.225N NaoH) and finally with acetone. *t* The optimal pH was found in the range of 5 to 9. The adsorption process reached the equilibrium after 90 and 105 minute at initial concentration of malachite green solution 4.9 and 7 mg/l, respectively. The process of removal follows pseudo second order kinetics. Equilibrium data fitted well in Langmuir isotherm model. The maximum adsorption capacity (monolayer coverage) was 303.03 (mg/g) at temperature 30^{0}C. The intra particle studies suggested the intra particle diffusion as rate controlling process. The negative values of ΔG^0 and ΔH^0 obtained from thermo dynamical analysis of the experimental data indicated the spontaneous and exothermic nature of the adsorption. [23] T. Santhi et al. (2009) studied a sample of raw (PR-Raw) and activated carbon (PR-Carbon) from prawn waste as an adsorbent for removal of malachite green (MG)) from aqueous solution at 28^{0}C. It was found that the amount of MG adsorbed increased as the sorbent particle size decreased. The percentage of adsorption increased as the adsorbent concentration increased. The value of initial pH 7 for PR-Carbon and pH 8 for PR-Raw, were found optimal for removal of MG effectively. When the dye concentration was increased the percentage of dye adsorbed decreases. The equilibrium adsorption capacity of MG onto the PR-Carbon is significantly larger than those onto the PR-Raw. From the values of R^2 it was concluded that the equilibrium data best fitted the Freundlich isotherm model. The biosorption processes followed the Pseudo –first order rate kinetics. Intra particle diffusion modeling indicating that Surface adsorption and intra particle diffusion were likely to take place simultaneously. [24]. Le Phan Linh et al.(2012) studied the removal of malachite green from aqueous solutions by adsorption onto rubber wood *(Hevea Brasiliensis)* sawdust in batch kinetic experiment. The equilibrium study showed that adsorption process of malachite green reached equilibrium after 2.5 hours and optimal pH was 5. As the temperature increases the adsorption amount increased. Equilibrium data fitted well in Langmuir isotherm model (R^2=0.9902) in compare to Freundlich isotherm model (R^2=0.7776). The maximum adsorption capacity (Q_0) (monolayer coverage) was found 27.4 (mg/g) at temperature 40^{0}C. [25] Shabudeen P.S. syed (2011) studied Kapok hull activated carbon (KHAC) as an adsorbent for removal of malachite green from aqueous solution. Here they used sulfuric acid (1:1) to activate the adsorbent. The adsorption was found independent of pH of the medium. It was also observed that the adsorption increased as temperature increases from 300 to 318K and further the increase in temperature did not have any influence upon adsorption. It was found that the data fitted well in Langmuir adsorption isotherm model as well as Freundlich adsorption isotherm model. Further, it was revealed that R_L values lay between 0 and 1 and the value of Freundlich parameter n lay between 2 to 10 at various temperature and particle sizes showing the adsorption of MG onto KHAC was fovourable. Adsorption followed the pseudo first order rate equation and the intra particle diffusion model indicated that more than one mode of sorption mechanism was in operation. From the thermo dynamic analysis of the experimental data the value of ΔG° , ΔH° and ΔS° were found which come out to be negative, positive and positive indicating the process as spontaneous, endothermic and there was a decrease in randomness at the surface of adsorbent after adsorption. It was observed that the ΔH° and ΔS° values increased with decrease of particle size. The positive and increased ΔS° values for smaller particle size indicated that the KHAC showed greater affinity towards the dye. It was observed that, the value of energy of activation for malachite green by KHAC was in between 5 to 20 kJ/mol confirms the activated adsorption.

Response surface method using Box- Behnken design of experiments was adopted and gives a mathematical model for the adsorption of dye stuff. The results obtained by adapting Box-Behnken model in the study of absorption of MG dyes on KHAC proves, absorption of dye depends only upon the particle size of absorbent and it was not influenced by pH or temperature. The experimental values and the predicted values of Box-Behnken design model were in close agreement with quadratic regression >98%. [26]. Jagdish Singh et al. (2013) studied the removal of malachite green from aqueous solutions by adsorption onto agricultural waste rice straw in batch kinetic

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experiment. The optimal pH of the solution was found to be 8 and the equilibrium time was about 15 min. The removal of MG was found increases as the initial concentration of the MG increases. The adsorption of MG increased with increase in temperature. The adsorption was found to follow the Pseudo –first order rate kinetics. The equilibrium data best fitted the Freundlich isotherm model. The Freundlich parameters n and K_F were obtained as 9.3, 10.3, 11.3 and 87, 90 and 92 mg/gm respectively at different temperature 25,30 and 35^{0}C. The values of ΔG^0, ΔH^0 and ΔS^0 obtained from thermo dynamical analysis of the experimental data were found negative, positive and positive respectively. [27]

S. Sivamani et al. (2009) investigated the removal of malachite green from its aqueous solution by Pithophora sp., fresh water algae by means of a batch system. The optimum pH was found to be 5 and equilibrium time as 10 min and the maximum dye removal rate was found to be 94.35%. It may be that the zero point charge for the prepared adsorbent could be found at a pH of 5. [28]. Anna Jasińska et al.(2013) studied the waste of rapeseed press cake (WRPC), obtained after the preparation of microbial culture medium, in a batch system as an adsorbent of malachite green (MG). The highest sorption of MG was observed after 180min in solution containing 50mg/L of MG and 2.5mg/L of WRPC at pH 6.5. The equilibrium data best fitted with the Langmuir isotherm model. MG sorption followed the pseudo-second-order rate kinetics. MG desorption efficiency (94.5%) from WRPC with the use of 0.1M NaoH solution was determined. [29]. Chowdhury .S et al. (2013) investigated thermo chemically modified Wheat bran with citric acid as a potential adsorbent for removal of Malachite Green (MG) from aqueous solutions in batch experiment. It was found that operational parameters, such as solution pH, adsorbent dose, initial adsorbate concentration as well as temperature, greatly influenced the adsorption efficiency of the adsorbent. The Langmuir isotherm model showed excellent fit to the adsorption data of MG. The sorption processes followed the pseudo-second-order rate kinetics. Thermodynamic study showed spontaneous and exothermic nature of the sorption processes [30]. Jia Tan et al (2012) used Waste newspaper fiber (WNF), separated and deinked it(denoted by DWNF) for use as an absorbent for removal of Malachite Green (MG) from aqueous solutions in batch kinetic experiment. The equilibrium study showed that adsorption process of malachite green reaches equilibrium after one hour but 88% of removal took place within 10min. the optimal pH of the solution was found to be 7. Equilibrium data was found fitted well in Langmuir adsorption isotherm model. The maximum adsorption capacity (Q_0) (monolayer coverage) was found 85.25 (mg/g) at temperature 40^{0}C. Sorption kinetic analysis revealed that adsorption of MG onto DWNF followed the pseudo second order rate model. From thermodynamic analysis they obtained value of $\Delta G°$ Gibbs free energy, $\Delta H°$ change in enthalpy, and $\Delta S°$ change in entropy were found negative, negative and positive respectively. [31]. Shanthi et al.(2012) studied adsorption of methylene blue and malachite green dyes from aqueous solution of their binary mixture on Commerical Activated Carbon (CAC), and Tamarind Kernel Powder (TKP), a biological waste material under different experimental conditions (Initial concentration, dose by varying of adsorbent, initial pH and contact time. Experimental values indicate that the rate of removal of dye decreases with the increase in the initial concentration of dye and vice versa .The amount of dye adsorbed increased exponently with the increase in the dose of adsorbent. The effect of initial pH of dye solution was studied at different pH value (Range of pH: MG & MB = 3 – 6.8 for CAC, MG & MB = 3 – 6.8 for TKP).The adsorption of these dyes on CAC & TKP in found to be highly pH dependent. The percentage removal of binary mixture of dyes (MG and MB) at 60 min. of contact time, is 97.51 for MG and 94.86 for MG by CAC, and 96.25 for MG and 93.45 for MB by TKP respectively, This reveals that the optimum contact time is 60 min for MG & MB for both the adsorbents (CAC and TKP). Sorption kinetic analysis revealed that adsorption of MG & MB binary mixture onto CAC and TKP followed the pseudo first order rate kinetic expression. The rate constant value is higher in TKP than in CAC. This shows that rate of adsorption is higher in TKP. This gives support for the efficiency of TKP. Adsorption data obeyed both Freundlich and Langmuir adsorption isotherms. Intra particle diffusion plots for the removal of dyes from their binary mixture by adsorption revealed the intraparticle diffusion was found to be rate determining step. [32]. K. RajasekharJia (2014)) used corn cob as an absorbent for removal of Malachite Green (MG) from aqueous solutions in batch kinetic experiment. The contact time needed for dye solution to reach equilibrium was found 100min. The result shows that there was no significant change in the present removal of dye over the entire pH range. The study reveals that percentage of adsorption increases with increasing the adsorbent dosage. IT was foumd that as the initial concentration of dyes increased the removal of % of dyes decreased. [33]

Sharma et al. (2013) studied the adsorption potential of agricultural waste material sugarcane baggase to remove malachite green dye from aqueous solution. The adsorbent was characterized by BET surface area measurement and FTIR analysis. It was observed that more than 95% removal efficiency was obtained within 120 min at adsorbent dose of 1 g/L for initial dye concentration of 50 mg/L. It was observed that with increase in temperature, adsorption capacity decreases indicating the adsorption is exothermic in nature. The high values of R^2 (~ 1) and good agreement

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between two q_e Values indicate that the adsorption system followed pseudo-second-order kinetic model and hence the process is chemisorptions controlled. From thermodynamic analysis the value of ΔG^o, ΔH^o, ΔS^o were found which came out to be negative, negative, negative respectively at every temperature under study. Adsorption mechanisms were investigated with intra-particle diffusion model, Furusawa and Smith model and Boyd's model which shows that both film diffusion and intra particle diffusion were simultaneously occurring during the adsorption. Langmuir isotherm model was fitted the best for the adsorption system with an adsorption capacity of 190 mg/g of adsorbent. [34]. Makeswari et al. (2013) studied and analysed the Competitive adsorption of malachite green (MG) in single and binary system on microwave activated epicarp of Ricinus communis (MRC) and microwave assisted zinc chloride activated epicarp of Ricinus communis (ZRC). It had indicated that ZnCl2 was a suitable activating agent for the preparation of activated carbon from epicarp of Ricinus communis by microwave radiation. SEM micrographs showed that the external surface of the chemically activated car-bon was full of cavities compared with untreated Ricinus communis. The activated carbon prepared could effectively used as adsorbent for the removal of basic dye from aqueous solutions. 5 was the optimum pH value observed for the adsorption of MG onto MRC and ZRC. It was observed that the percentage of adsorption increases with increase in adsorbent dose from 0.2 g to 1 g in MG with the concentration of dye solution of 100 mg/L. It was seen that the percentage removal decreased with the increase in initial concentration. Adsorption Isotherm Studies for adsorption of MG onto MRC (S), MRC (B), ZRC (S), ZRC (B) revealed that the obtained data was best fitted in Langmuir isotherm model compare to Freundlich isotherm model, Dubinin-Radushkevich model, Temkin model. The maximum adsorption capacity (monolayer coverage) for adsorption of MG onto MRC (S), MRC (B), ZRC (S), ZRC (B) were found 12.6500, 11.7647, 24.3900 and 20.4081 mg/gm respectively. The higher R^2 values confirm that the sorption process of dyes onto MRC and ZRC follow a pseudo-second-order kinetic model. From Intra Particle Diffusion Model it was observed that the plot between q_e Vs $t^{1/2}$ did not pass through the origin for both the single and binary system which indicated that surface adsorption and intra-particle diffusion were concurrently operating during the MRC and ZRC interactions. MG adsorption rate onto MRC and ZRC was greater in single system (S) than in binary system (B) due to the competitive adsorption of dye onto the active site of the activated carbon. Among MRC and ZRC, ZRC shows most adsorption ability than MRC in single and binary system. [35]

Rajeshkannan et al. (2010) studied the Hydrilla verticillata, a cheap and widely available biomass as a potential adsorbent to remove malachite green from the aqueous solutions. The effects of operating parameters such as temperature, adsorbent dosage, contact time, adsorbent size, and agitation speed on the sorption of Malachite green were analyzed using response surface methodology (RSM). The proposed quadratic model for central composite design (CCD) fitted very well to the experimental data that it could be used to navigate the design space according to ANOVA results. The optimum sorption conditions were determined as temperature - 43.5ºC, adsorbent dosage - 0.26g, contact time - 200min, adsorbent size - 0.205mm (65mesh), and agitation speed - 230rpm . Freundlich isotherm fits the data better with R^2 0.991 than Langmuir isotherm with R^2 0.963. Freundlich parameters are K_f - 3.17, n- 1.299. The maximum adsorption capacity was obtained from Langmuir isotherm (91.97 mg/g) at a solution pH ~8.0. From the kinetic and equilibrium studies it was found that pseudo second order kinetics and Freundlich isotherm fits the data well respectively. Intra particle diffusion models analysis revealed that both the external diffusion as well as intra particle diffusion contributes to the actual sorption process. [36]. Subbareddy Y et.al.(2012) investigated the potential use of a low-cost Fuller's Earth (FE) for removal of Malachite Green oxalate (MG) dye from an aqueous solution. The experimental equilibrium data were found best fitted with the Langmuir model. The maximum adsorption capacity of FE was found to be 1.96 x10-4mol/g for MG at room temperature. The energy of adsorption was 25.828 kJ/mol indicating chemisorptions. Adsorption data of MG onto FE was fitted well by the pseudo second order model. From thermodynamic analysis ΔG^o and ΔH^0 were found negative and positive respectively suggesting the process of removal of MG by FE is a spontaneous and endothermic nature. [37]. Madrakian .T et al. (2012) investigated the removal of crystal violet, CV, onto the Magnetite nanoparticles loaded tea waste (MNLTW) obtained from treatment of tea waste as naturally occurring waste by FeCl3_6H2O, FeCl2_4H2O and NH_3 solution. It was observed that the dye became adsorbed after 35 min and under the optimized conditions, up to 98% of dyes can be removed from the solution onto the MNLTW surface and the optimal pH was found 10. The equilibrium data of adsorption of CV onto MNLTW best fitted with Langmuir model with R_L lying between 0 to 1($0 < RL < 1$). Maximum adsorption capacities at 25ºC for removal of CV were found to be 129.87 mg/g. It was observed that that adsorption data followed the pseudo second-order kinetic model. [38]. Karla Aparecida Guimarães Gusmãoa et al. (2012) have investigated the adsorption of crystal violet onto the Succinylated sugarcane bagasse (SCB 2) prepared from sugarcane bagasse, an important agricultural waste, after only one chemical modification under several operating conditions. Equilibrium adsorption times was found to be 20 hours for CV and optimum pH for removal of CV

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was found to be equal to 8.0. The experimental data fitted very well to the Langmuir model. Maximum adsorption capacities for removal of CV were found to be 1273.2 mg/g. The adsorption process was well described by pseudo-second-order model; however the intraparticle diffusion model yielded three linear regions suggesting multiple sorption rates. [39]

Prasad and Santhi (2012) studied the adsorption of cationic dyes (crystal violet and rhodamine B) from aqueous solution onto *Acacia nilotica* leaves as an eco-friendly adsorbent. The equilibrium adsorption was practically achieved in 120 minutes. The highest removal of dyes was obtained at pH 6. The removal efficiency increased with increase in agitation time and initial dye concentration. The equilibrium data were best described by Langmuir isotherm model with maximum monolayer capacity of 33 and 37 mg g-1 for crystal violet and rhodamine B respectively. The adsorption kinetics can be successfully fitted to pseudo–second order kinetic model. The result of the intraparticle diffusion model suggested that intraparticle diffusion might not be the only rate controlling step. Desorption study revealed that the recovery of the dye from adsorption was possible. [40]. M. M. El. Jamal .et al. (2011) investigated the adsorption of crystal violet onto the Chaetophora Elegans Alga under several operating conditions. Equilibrium adsorption times was found to be 20 minutes for CV and optimum pH for removal of CV was found to be greater than 8.0. The experimental data fitted very well to the combined Langmuir-Freundlich model. Maximum adsorption capacities for removal of CV were found to be 158.7 mg/g at temperature 25^0C. The adsorption process was well described by pseudo-second-order model; besides the thermodynamic analysis revealed that the present adsorption process is endothermic and spontaneous as ΔH^0 and ΔG° were found positive and negative respectively. [41]

Satish Patil et al. (2011) have investigated the naturally available materials viz. the Mangrove plant (Sonneratia Apetala) leaf powder (MPLP), Mangrove plant (Sonneratia Apetala) fruit powder (MPFP), Mango (Mangifera Indica) leaf powder (MLP), Tamarind (Tamarindus indica) fruit shell powder (TFSP), Teak tree (Tectona Grandis) bark powder (TTBP), Almond tree (Terminialia cattapa) bark powder (ATBP) as an adsorbent for removal of crystal violet from aqueous solution. The monolayer (maximum) adsorption capacities (Q_0) of MPLP, MPFP, MLP, TFSP, TTBP, ATBP were found to be 200, 250, 200, 142.857, 200, 166.667 mg/g respectably. The pseudo second order model best fits the kinetics of adsorption. Intra particle diffusion plot showed boundary layer effect and larger intercepts indicates greater contribution of surface sorption in rate determining step. Adsorption was found to increase on increasing pH, increasing temperature and decreasing particle size. ΔG, ΔH and ΔS values showed favorable, spontaneous, endothermic physical adsorption with increased disorder and randomness at the solid solution interface of CV with biosorbents. Adsorption capacities of different adsorbents towards CV were found to be of the order of MPLP > MPFP > TTBP > MLP > ATBP > TFSP. [42]. Nagda, G. K et al (2008), Studied Raw tendu waste (TLR), sulfuric acid carbonized tendu waste (TLR-CM) and tendu waste treated with dilute sulfuric acid (TLR-2N) as sorbent for uptake of crystal violet from aqueous solutions. The experimental result showed that it followed the pseudo-second-order kinetics and followed the Langmuir adsorption isotherm. The maximum adsorption capacities for crystal violet for TLR-2N, TLR and TLR-CM are 67.57, 42.92 and 22.47 mg/g respectively. Interestingly, milder acid treatment of the tendu waste enhanced biosorption, whereas drastic acid carbonization of tendu waste resulted in reduced adsorption of dye. [43]

Verma and Mishra (2010) used rice husk carbon to adsorb dyes (crystal violet, direct orange and magenta). It was found that the optimum time was 45 minutes and there was decrease in adsorption capacity in the low pH region. Also, the removal of dyes increased with increase in temperature and there was increase in removal of dyes with increasing adsorbent dose. The removal percentage decreased with increase in initial concentration of dyes. [44]. Bharathi K. S. et al.(2012) used Citrullus lanatus (Watermelon) rind, an agricultural solid waste as a bio-sorbent for the removal of crystal violet from aqueous solutions. The maximum amount of CV adsorbed corresponding to the equilibrium time of 180 min was found to be 87% for a dose of 1.0 gm/lit of the adsorbent. The optimal pH value for the sorption of CV was found to be in the range of 8.0-12.0. The extent of adsorption of CV was found to increase with increase in temperature in the range of 30-500C, indicating the process to be endothermic in nature. The experimental equilibrium data best fitted to the Freundlich isotherm model. The adsorption capacity was found to be 4.82 mg/g at 30ºC. The kinetics of adsorption was found to follow pseudo-second-order kinetic model. From thermodynamic analysis the value of ΔG^0, ΔH^0 and ΔS^0 were found negative, positive and positive respectively. [45]. Sagnik Chakraborty et al. (2011) studied, equilibrium, kinetics and thermodynamics of Crystal Violet (CV) adsorption onto NaoH modified rice husk (NMRH). The adsorption was favored at higher pHs and lower temperatures. Adsorption data were well described by the Freundlich model, although they could be modeled by the Langmuir model as well. The adsorption process followed the pseudo-second order kinetic model. It was found that intraparticle diffusion was not the sole rate controlling step. The activation energy (Ea) of the system was calculated as 50.51 kJ mol−1. Thermodynamic parameters suggest that the adsorption is a typical chemical process, spontaneous, and

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exothermic in nature. (Sagnik Chakraborty, Shamik Chowdhury, Papita Das Saha, Adsorption of Crystal Violet from aqueous solution onto NaoH-modified rice husk, Carbohydrate Polymers 86 (2011) 1533– 1541).

Rice husk carbon was used to adsorb dyes (crystal violet, direct orange and magenta) by Verma and Mishra [2010]. It was found that the equilibrium time was 45 minutes and there was decrease in adsorption capacity in the low pH region. Also, the removal of dyes increased with increase in temperature and there was increase in removal of dyes with increasing adsorbent dose. The removal percentage decreased with increase in initial concentration of dyes. [46]

III. Further Scope of Study

From the above review it can be observed that a number of biomaterials have been tested as an adsorbent for the removal of CV and MG in batch mode experiment. These studies will be proved useful only when suitable technology is being evolved for their actual use in removal of these dyes from industrial effluents containing CV and MG. Though lots of works have been done to find out the effectiveness of biomaterials in removal of CV and MG by means of adsorption but very little work has been done to understand the actual mechanism of adsorption of these dyes onto the various biomaterials. This is one of the areas where researchers have to put their attention. There is the need to develop mathematical model to predict the effect of various parameters like the rotational speed, pH value of solution, initial concentration of dye, dose of adsorbent, temperature. Response surface methodology (RSM) is an attempt in this direction but still much more is required to evolve mathematical models which fully explain the various factors. During the last five years a number of biomaterials/agricultural waste have been tested as an adsorbent for the removal of the crystal violet and malachite green dye from its aqueous solution by researchers. These biosorbents shows excellent adsorption capacity for the CV and MG dyes and can be used as an alternative of activated carbon.

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A Case Study on Social and Economic Development of Rural Areas over Last Three Decades: Bangladesh Perspective

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Abstract- Bangladesh is an over populated country with an approximate population of 154.7 Million [1]. Presently it is moving forward to catch the line of mid income countries from the low income country in a steady pace. This progress can be perceived from the improvement in the education, health, GDP, GNI as well as in other basic development indicators over the years. The main focus of this study is to find out the changes in the rural economic and social development over last three decades and appraise the situation of the rural areas (three villages) comparing to the overall development of Bangladesh. As per World Bank report, current primary enrolment is 114% (2011,%gross), Poverty headcount ratio at national poverty line is 31.5% (2010),Life expectancy at birth is 70 years (2012), GNI per capita, Atlas method is $840 current USD (2012). Life expectancy at birth has been increased significantly over the years as well as the primary enrolment. The progress in sanitation and health awareness to the villagers also increased during the study period. But the percentage of rural people living below the poverty line has not been decreased due to very little change in their livelihood and earnings. Water supply during the dry season remains a headache for the rural people still now and most importantly GNI per capita of these rural areas are not satisfactory.

Keywords: rural development, social development, economic development, development indicators, GDP, GNI.

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A Case Study on Social and Economic Development of Rural Areas over Last Three Decades: Bangladesh Perspective

B. N. Shaha [α] & M. N. B. Zaman [σ]

Abstract- Bangladesh is an over populated country with an approximate population of 154.7 Million [1]. Presently it is moving forward to catch the line of mid income countries from the low income country in a steady pace. This progress can be perceived from the improvement in the education, health, GDP, GNI as well as in other basic development indicators over the years. The main focus of this study is to find out the changes in the rural economic and social development over last three decades and appraise the situation of the rural areas (three villages) comparing to the overall development of Bangladesh. As per World Bank report, current primary enrolment is 114% (2011,%gross), Poverty headcount ratio at national poverty line is 31.5% (2010),Life expectancy at birth is 70 years (2012), GNI per capita, Atlas method is $840 current USD (2012). Life expectancy at birth has been increased significantly over the years as well as the primary enrolment. The progress in sanitation and health awareness to the villagers also increased during the study period. But the percentage of rural people living below the poverty line has not been decreased due to very little change in their livelihood and earnings. Water supply during the dry season remains a headache for the rural people still now and most importantly GNI per capita of these rural areas are not satisfactory.

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I. Introduction

The world Bank report announced in June 2013 shows that Bangladesh had reduced the number of people living in poverty from 63 million in 2000 to 47 million in 2010 which indicates a significant progress towards the first Millennium Development Goal which is to eradicate extreme poverty and hunger. Gross National product per capita in Bangladesh is around 600 USD and it averaged 311.60 USD from 1960 until 2012 [1].Bangladesh is also making progresses in reducing its poverty rate and an average GDP of 5.5% has been also increased in the time period of 1994 to 2012 [2]. There has been a reduction of poverty by 1% of the population by each year since 1990. Most of these poor peoples are living in rural areas of Bangladesh with very little opportunities and lack of skills except the one they are doing for years to maintain their daily needs. Although the statistics of different organizations have been showing constantly that the number of populations living below $1 earning per day has been reduced by almost fifty per cent, but this study focuses to identify the deficiencies of the rural people earnings to the average earnings of the country itself. Bangladesh is now a country with approximately 150 million populations and about 71.11% of the total population is living in rural areas [3]. Among these vast numbers of rural population about 36% of them are living under the poverty line [4]. They suffer from persistent food scarcity, inadequacy of land, paucity of potable water supply, lack of education, health and sanitation knowledge as well as serious illness or disabilities. There are also a large percentage of rural populations who are considered moderately poor. Although Bangladesh is progressing towards the mid income nations in a steady pace, rural peoples are far behind than the urban dwellers in every aspect of development. Their lack of knowledge, education, limited resources as well as limited water supply and health awareness are the main reason behind this variance in development. Even with this unfavourable living condition, they are not standing still and watching the progress of the country but are trying hard to improve their conditions within their limits. Their improvement in primary education over the years has been impressive.

Although there is lack of opportunity and inequity in education systems, the literacy rate of rural areas is booming through Technology. Technology helps the rural students to think that they are no less than any students who are studying at city schools and colleges which motivate them to work harder to achieve their goals [5].

II. Methodology and Data Collection Procedure

This study has been conducted in three villages named Bhugli, Kawnia and Lakhsmipur. These villages are located in Mymensinghsadar Upazila in the district of Mymensingh (Latitude: N24° 51´9.155´´ and Longitude: E 90°12´56.068´´). Data was collected from mostly primary sources, which was collected directly from the villagers as well as some local representatives through face-to-face structured interviews. A total

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number of 30 respondents from these villages have been selected based on their age and number of years they are living in these villages. Most of these respondents are living in this area from their childhood and their families are living here for generations which ensure the real pictures of these areas during the study periods. As this study focuses on the social and economic development of this rural area in last three decades, the respondents selected are of age 50-60 years. They have been asked specific questions about the changes of their living conditions, main professions, sanitations, water supply etc. within the study period (1980-2014).

After collecting and processing of these raw data's within the study period, the calculation of the development indicators has been done and compared with the development of Bangladesh based on the World Bank report.

III. Results and Discussion

Population of the study area has not been changed significantly over the study period. Although the population of Bangladesh has been increasing at a steady pace, but due to the death of the older peoples and the movement of the adults towards the urban areas helping to keep the population approximately same over the last three decades. Total population of study area is about 300 approximately.

The age distribution of the populations shown in the table-1 represents the large numbers of working age population in these areas. From the age distribution table, it can be inferred that about 60% of total population aged below 40 years and the percentage of population between 60-80 years is very low (about 8%) and there is no person who is 80 or more years old at present. Although local people confirmed that the villagers who have been deceased in the last 20 years are of mostly aged between 70-100 years.

Table 1 : Gender and Age distribution of population of the study area

Age Range	No. of People	No. of Men	No. of women
0 - <10	51		
10 - <20	21		
20 - <30	48		
30 - <40	54		
40 - <50	54	159	132
50 - <60	39		
60 - <70	9		
70 - <80	15		
Total	291	54.6%	45.4%

The reason behind long life of the last generation is very simple and straight forward to the villagers. They think that at the past, there was less contamination in foods; food supply was abundance as well as the environment was less polluted which ensured a long life. But presently it seems the life span of the population of the area has been decreased significantly. According to local people, this happens due to the contaminated foods and the scarcity of nutrition which were in abundance in the past. Among all the peoples, nearly 55% are men and the rests are women.

Next when they have been asked about the main professions and income sources of them, the response from these peoples are not unusual. The income sources of the families are different to each other. Most of the family's incomes come from the male head of the family and most females work as housewives and manage family and children. But in recent years it has been observed that female members also coming out to work or to help their husbands to ensure their family's prospect. Figure-1 shows that about 50% of the total families depend directly on agriculture for their living and about 20% (small business) or more families depend on agriculture indirectly because, small businesses in the study area are largely depended on agricultural products. Local people say that dependency on agriculture is decreasing over the years due to the unavailability of power sources, fertilizer and proper irrigation when needed. Also the increased cost of production and the uncertainty of the yield product market are also forcing the villagers to shift to other way of earning their livelihood. Although they are trying to moving forward to other professions, agriculture still remains as the major source of their incomes and as there is very little chance of the area to be industrialized soon, it will take time, better water supply system, education as well as development of human skills to be able to dependent in other profession.

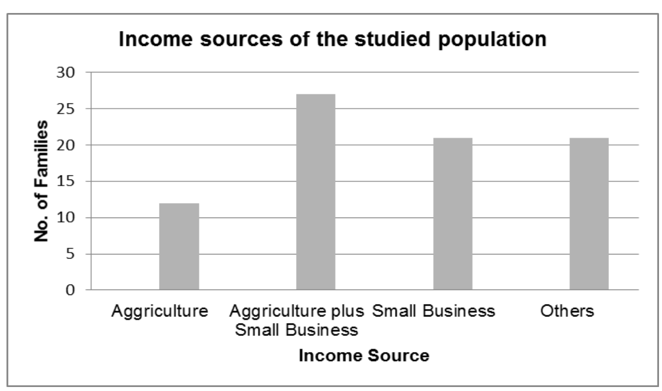

Figure 1 : Income sources of the studied area

Along with income sources, water supply, sanitation and health awareness are some of the major defining factors of social prospects. As the survey results show the water supply system of these areas at present is not the worse of the country but there is

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enough space for improvement. Water is life and life on earth is linked to water. Our existence is dependent on water. In the recent past, peoples of this area were used to collect water from open dug wells for their drinking purposes and ponds and other surface water bodies for daily uses. In the nineties there were no such open dug wells in the study area but shallow hand operated tube well and three hands operated deep tube wells. Most of the people of the area used to collect tube well water only for drinking purposes but in the recent years they are changing that trends of water uses and also started to use tube well water for washing, taking bath, animal feeding and for other daily purposes because, nowadays it is almost obvious to have at least one tube well in every households. So it seems they are well prepared for their water demands. But when it comes to the dry seasons all shallow tube wells are becoming useless for the past few years and numbers of deep tube wells are also not too much. On an average every five or six households use one tube well for their drinking water and they go back to their old trends to use tube well only for drinking water. Table-2 shows the sources of water of the study area in the last three decades and the limitations as well.

Table 2 : Available Water Sources of the Study Area

Time Period	Source of water				
	No. of Ponds	No. of Hand operated Tube well	No. of Hand operated Deep Tube well	Rain Water system	Electric Motors /Pump
1980-1990	5	6	3	Not Available	Not available
1990-2000	5	15	4		
2000-2010	5	27	7		
2010-2014	5	32	11		

To improve the water supply during dry season, rain water harvesting may be considered as one of the most important sources. The water can be stored, used for washing and cleaning purpose and most importantly to recharge the ground water. It can also help the villagers to live a sanitary life and keep them safe from waterborne diseases.

Sanitation and health awareness is the key factor of social class. These villages used to have small brushes here and there until past 5 or 10 years. Peoples of these villages also were not fully aware of sanitation and health problems due to open defecation. Due to this habit of excretion many of the villagers used to have water borne diseases by using open surface water bodies filled with contaminated water. Table-3 shows that in 1990s there were less than 20% of peoples used any type of latrines and about 30% of the total population were somewhat aware of sanitation but due to lack of motivation they did not use latrines.

Table 3 : Sanitation and Health

Time Period	No. of Households have a latrine	No. of Households have a sanitary latrine	Percentage of people uses latrine	Percentage of people aware of sanitation and Health
1980-1990	15	3	<20	≤ 30
1990-2000	36	9	28-30	45-50
2000-2010	45	32	65-67	≥ 70
2010-2014	58	54	>95	95-99

But due to government's good intentions and advertising programs as well as different non government's awareness programs, people's perspectives changed a lot and now about 95% of the total population uses latrines and almost all of them are aware of health and sanitation. Also they wash hands before taking meals as well after using latrines with hand washing liquids or soap which has reduced the water borne diseases significantly.

As they have been aware about their health, pure drinking water, and sanitation during the last decades, they have changed their social and economic conditions a lot. But they are not unaware of education too. Although the main income sources does not show any hint of the educational background of these areas, the study shows amazing records of primary education from the early nineties. The enrolment in primary schools data shows that these areas are ahead by significant

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percentage than the gross primary enrolment of the country itself. For an instance, in 1980 overall primary enrolment of the country was 70 per cent but these areas enrolment to primary schools was approximately 90 per cent of the population who were aged between five to seven and this data was collected by inquiring the information about the basic literacy of the peoples aged around 40 years old. Moreover that, enrolment in secondary education was also good which is clear from the table-4.

Table 4 : Educational Scenario

Time Period	Primary Education (% of population of official Primary Education Age)	Secondary Education (% of primary educated population)		Higher Study (approximate % of population with secondary education)	
		Enrolment	Completion	Enrolment	Completion
1980	90	70	30	5	2
1990	94	80	50	8	3
2000	100	100	60	14	10
2010	100	100	90	40	35
2014	100	100	100	52	50

But the percentages of drop out from the secondary schools were significantly high during the period of 1980 to 2000. In this time period, the percentage of drop out students has been decreased in a steady pace and now it is minimized to its optimum. Although the primary education and secondary education rate is fair enough for a rural area, the percentage of enrolled students in primary schools who enrolled or completed higher education is very low. In 1980's about 5 per cent of the enrolled students in primary school had enrolled or completed higher studies which are rare but true scenario for the study area where the public concern about primary education is so decent. There may be a lot of reasons behind these huge numbers of high school dropouts but most important ones are, the limited knowledge about the higher study, the cost of higher study which is fearful to the rural people, the trend of following the parental business, the lack of opportunity available at the areas etc. But even after all these limitations people are now more cognizant about their children's future and also aware of the benefits of higher studies which includes but not limited to the financial benefits but also the social status of a family. The recent data shows that about 50 per cent of the population enrolled in primary school are enrolling or completing the higher education which is a significant improvement in the last three decades.

From the above information and discussion it is clear that the villagers of these areas have been improved their living standard by a significant margin. They have been aware of the need of education, pure drinking water, sanitation to improve their living conditions for quite some times. They are trying to change their life standard by working hard, using their limited resources to educate their children and taking the advantage of government's scholarship program. This is very clear from the above statistics as well as on field experience. They are now thinking of the future of their children and dreaming for an educated life which they do not have. They want to provide the best opportunities for their children within their capacity. But the financial aspects of these areas are not satisfactory as education or sanitation or consciousness of pure drinking water supply. Their income per person in a year is far behind than the Gross National Income (GNI, US dollar). This situation has not been changed during the last three decades and even now they live under the poverty line which is clear in the figure-2. The main reasons behind this is, less opportunity of work, the lack of craftsmanship, trends of following their ancestors which preclude them from entering a new working environment.

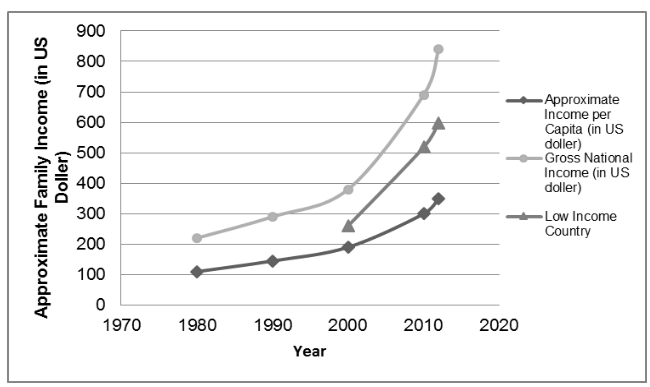

Figure 2 : Approximate Family Income (in US$) of the studied area

IV. Conclusion

The overall improvement of the study area in the fields of education, sanitation as well as public consciousness has been found impressive. At present, almost all of the families are using a safe and potable source of water, 100% students aged between 5-6 years are going to primary schools, more than ninety five per

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cent of the total populations are aware of sanitation and health. They have changed their social views about education, women empowerment, sanitation and many other old issues. But the improvement of their earning is not as satisfactory as other development indicators. They are still living under the poverty line and it will take a good amount of time as well as some thoughtful steps to improve their financial condition. Even after that the future prospect of the study area is better than many other rural peoples who have not achieved the prospect they have already grasped under their control. The number of educated person has been increasing in a balanced way which will change the livelihood of the peoples as well as will help them to cross the borderline of poverty and dream for a better future.

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Analysis of Pre-Stressed Pseudo Box Bridge using Inverted-T Girder and Splicing Technique

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Abstract- The paper is for the structural analysis of continuous simply supported pre-stressed inverted-T girder using splicing technique. This paper represents variation of inflection points (point of contra flexure) for different variable loading conditions such as superimposed dead load, lane load, HS-20 truck load etc. The load (live load) for which inflection point changes its location greatly, amount of changes etc. also noticed and amount determined with several trials in this research. Finite element analysis method applied in this case for maximum bending and shear. The effect of false box action considered and found that due to false box action the reduction of bending stress shows lighter section of inverted-T girder. Without considering box action it shows inverted T-girder depth requires greater depth whereas false box girder action reduces its depth extensively.

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ANALYSISOFPRESTRESSEDPSEUDOBOXBRIDGEUSINGINVERTEDTGIRDERANDSPLICINGTECHNIQUE

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Analysis of Pre-Stressed Pseudo Box Bridge using Inverted-T Girder and Splicing Technique

K. M. Bipul Shahriar [α], Sakia Azam [σ], Mezbah Ul Alam [ρ] & Arhan Dewan [ω]

Abstract- The paper is for the structural analysis of continuous simply supported pre-stressed inverted-T girder using splicing technique. This paper represents variation of inflection points (point of contra flexure) for different variable loading conditions such as superimposed dead load, lane load, HS-20 truck load etc. The load (live load) for which inflection point changes its location greatly, amount of changes etc. also noticed and amount determined with several trials in this research. Finite element analysis method applied in this case for maximum bending and shear.

The effect of false box action considered and found that due to false box action the reduction of bending stress shows lighter section of inverted-T girder. Without considering box action it shows inverted T-girder depth requires greater depth whereas false box girder action reduces its depth extensively.

I. Introduction

a) General Concept

Large bridge with long span and vertical clearance for navigation is required in some places. Pre-stressed concrete girder bridge is constructed where river is deep and more navigation clearance is required. Post tensioned box girder is the latest system for long span bridge for which modern construction technologies as well as huge construction fund are required.

The box girder normally comprises either prestressed concrete, structural steel, or a composite of steel and reinforced concrete. The box is typically rectangular or trapezoidal in cross-section. Box girder bridges are commonly used for highway flyovers and for modern elevated structures of light rail transport. Although normally the box girder bridge is a form of beam bridge, box girders may also be used on cable-stayed bridges and other forms. This study is carried out with the intension of finding some other alternating as can be used as compatible to post tensioned box Girder Bridge.

b) Objective of the Study

The objective of the study is to analysis of a pseudo box girder bridge of a 750m long multiple span (50m each span) using on 2 lane highway.

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c) Scope of the Study

To use splicing technique for pre-cast inverted T-girders which are placed very closely and act as pseudo box section as can be used for long span bridge.

d) Approach of the Study

The approach of structural analysis is made by STAAD pro 2006, which is based on numerical finite element grid analysis theory. The study selected suitable section of inverted-T girders of two different lengths of 28m and 22m long which are to be applied for making continuous simply supported 750m long bridge.

II. Modeling and Analysis

a) Introduction

The bridge was analyzed as considering simply supported multi – span RCC deck slab supported on pre-stressed post tensioned concrete inverted-T girder. The bridge length is 750m comprising of 15 number spans (50m each). The bridge is analyzed as continuous multiple spans with pre-stress concrete inverse-T girder. Fixed permanent loading were analyzed to find out the inflection points. The change of inflection point was determined by different live load combinations. STAAD-pro software and AASHTO-2003 were used as design tools for numerical grid analysis and loading criteria respectively.

b) Bridge modeling configuration

Total length: 750 m, 15 span: 15 @ 50m, No. of lane: 2, Type of support: fixed and hinge support analysis purpose only, Girder type: inverse-T girder, No. of girder: 12, Cross beam type: rectangular (two types).

Bridge deck: Total width: 13.543m, Carriage way: 11.033m, Footpath with curb: 0.65 * 2, Parapet: 0.255 * 2.

Type of superstructure: RCC deck slab (150mm thick) supported on simply supported post-tensioned concrete spliced inverted-T girder.

Type of construction: Pre-cast inverted-T girder and spliced cast-in-situ on Conventional Propping System.

Curvature: horizontal: Straight, vertical: 1.0% parabolic (as open to bidder).

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c) Member Properties

Inverse-T girder parameter:	Box section of single cell:
Top flange width: 410mm	Top flange thickness: 150mm
Thickness of top flange: 625.1mm	Web thickness: 300mm
Depth of girder: 1510mm	Bottom flange thickness: 256mm
Thickness of web: 210mm	Height of box: 1660mm
Bottom flange width: 990mm	
Thickness of bottom flange: 256mm	

Overall dimensions 990x1510 mm

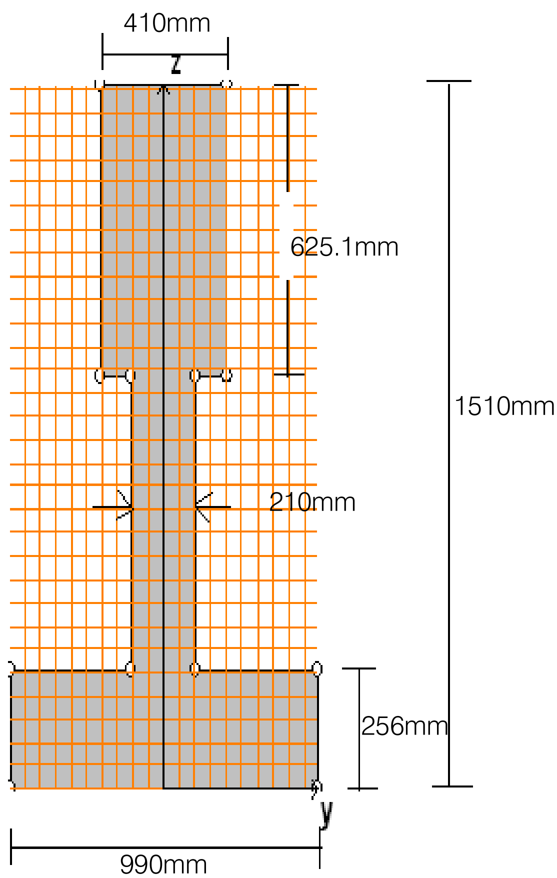

Figure 1 : Section of inverse-T girder

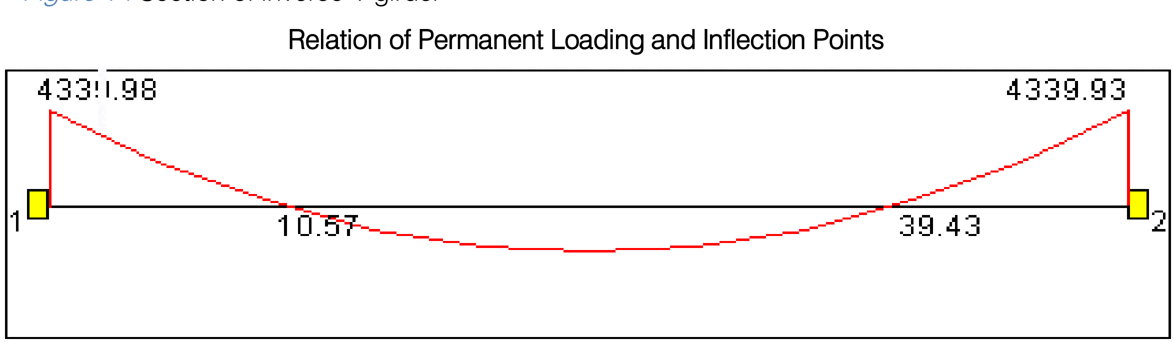

Fig 2 : Typical Inflection Point Diagram

III. Results and Discussion

Structural analysis of 750m continuous girder has been performed by using STAAD pro 2006 to find out inflection points for splicing which deals with the finite element analysis. We have compared the analysis result of single inverted-T girder, transverse box section and longitudinal box section to find out the depth and thickness of box Girder Bridge for different loadings to join the girder successfully at site.

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a) Results for Single Inverted-T Girder analysis

Table 1 : Combination-1 (SW+SDL) for Edge Girder

Beam	Beam results								
	Moments (max) (kN-m)			Shear (kN)			Deflection (Max.) (m)	Inflection point (m) from left support	
	Left support	Mid point	Right support	Left support	Mid	Right support	……..		
G1	4698.32	-2349.149	4698.32	563.796	0.001	563.791	0.102	10.57	39.43
G2	4698.28	-2349.116	4698.36	563.793	-0.002	563.792	0.102	10.57	39.43
G3	4698.27	-2349.139	4698.33	563.794	-0.001	563.795	0.102	10.57	39.43

Table 2 : Combination-1 (SW+SDL) for Interior Girder

Beam	Beam results								
	Moments (max) (kN-m)			Shear (kN)			Deflection (Max.) (m)	Inflection point (m) from left support	
	Left node	Mid point	Right node	Left support	Mid	Right support	……..		
G1	4339.979	-2169.982	4339.951	520.796	0.001	-520.795	0.094	10.57	39.43
G2	4339.949	-2169.952	4339.945	520.793	-0.001	-520.793	0.094	10.57	39.43
G3	4339.938	-2169.972	4339.965	520.794	-0.001	-520.795	0.094	10.57	39.43

Table 3 : Combination-2 self weight (SW) + Superimposed dead load (SDL) + Lane Load (UDL) + Concentrated Load in Mid Support of the Bridge

Beam	Beam results								
	Moments (max) (kN-m)			Shear (kN)			Deflection (Max.) (m)	Inflection point (m) from left support	
	Left node	Mid point	Right node	Left support	Mid	Right support	……..		
G1	5167.067	-2833.522	5167.038	600.046	-39.999	-600.045	0.119	10.78	39.22
G2	5167.031	-2833.485	5167.028	600.043	-40.002	-600.043	0.119	10.70	39.22
G3	5167.020	-2833.509	5167.050	600.044	-40.001	-600.045	0.119	10.78	39.22

Table 4 : Combination-3 self weight (SW) + Superimposed dead load (SDL) + Lane Load (UDL) + Concentrated Load in Edge Support of the Bridge

Beam	Beam results								
	Moments (max) (kN-m)			Shear (kN)			Deflection (Max.) (m)	Inflection point (m) from left support	
	Left node	Mid point	Right node	Left support	Mid	Right support	……..		
G1	4667.065	-2333.522	4667.035	560.046	0.001	560.045	0.104	10.57	39.43
G2	4667.032	-2333.489	4667.030	560.043	-0.002	560.056	0.104	10.57	39.43
G3	4667.021	-2333.512	4667.052	560.044	-0.001	560.062	0.104	10.57	39.43

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Table 5 : Combination-4 self weight (SW) + Superimposed dead load (SDL) + Lane load (UDL) + HS 20-44 Truck Loading at Center of the Interior Girder

Beam	Beam results								
	Moments (max) (kN-m)			Shear (kN)			Deflection (max) (m)	Inflection point (m) from left support	
	Left node	Mid point	Right node	Left support	Mid	Right support	……..		
G1	5311.783	- 2154.362	5380.629	538.668	-21.377	642.01	0.088	10.14	37.95
G2	5380.639	- 3639.122	5434.46	643.930	-17.411	583.021	0.170	10.15	40.04
G3	5434.402	- 2140.849	5434.53	583.033	22.988	583.11	0.087	12.16	39.89

Table 6 : Combination-5 Self weight (SW) + Superimposed dead load (SDL) + Lane load (UDL) + HS 20-44 Truck Loading at Center of Left Exterior Span and Interior Span

Beam	Beam results								
	Moments (max) (kN-m)			Shear (kN)			Deflection (max) (m)	Inflection point (m) from left support	
	Left node	Mid point	Right node	Left support	Mid	Right support	……..		
G1	5669.964	-3246.013	5931.432	639.779	-21.562	658.11	0.135	10.97	38.97
G2	5931.422	-3.265	5277.88	658.076	-3.265	578.41	0.152	11.12	40.08
G3	5277.897	-2180.143	5277.900	578.344	18.299	578.52	0.091	11.84	39.79

Table 7 : Combination-6 self weight (SW) + Superimposed dead load (SDL) + Lane load (UDL) + HS 20-44 Truck Loading at Center of All Span

Beam	Beam results								
	Moments (max) (kN-m)			Shear (kN)			Deflection (max) (m)	Inflection point (m) from left support	
	Left node	Mid point	Right node	Left support	Mid	Right support	……..		
G1	5739.010	-3280.833	5792.63	643.933	-17.408	645.451	0.138	11.03	39.20
G2	5792.739	-3267.294	5643.851	645.541	-15.800	643.851	0.137	11.12	39.22
G3	5643.931	-3253.819	5643.92	643.931	-17.410	643.931	0.135	11.10	39.13

Table 8 : Combination-7 self weight (SW) + Superimposed dead load (SDL) + Lane load (UDL) + HS 20-44 truck loading at First Support of Interior Span

Beam	Beam results								
	Moments (max) (kN-m)			Shear (kN)			Deflection (max) (m)	Inflection point (m) from left support	
	Left node	Mid point	Right node	Left support	Mid	Right support	……..		
G1	5395.070	-2385.671	4847.661	708.663	-10.774	633.131	0.108	9.92	39.12
G2	4847.678	-2339.665	4863.512	633.028	-6.713	630.891	0.105	10.24	39.16
G3	4863.617	-2392.653	4863.65	630.798	-2.239	630.992	0.109	10.28	39.52

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Table 9 : Maximum and Minimum Inflection Point

Beam	Minimum inflection point from left support of load combination (1st zone)	Maximum inflection point from left support of load combination (1st zone)	Minimum inflection point from left support of load combination (2nd zone)	Maximum inflection point from left support of load combination (2nd zone)	Splicing zone (m)	
					1st	2nd
B1	9.92	11.03	39.12	39.43	1.11	0.31
B2	10.15	11.12	39.16	40.08	0.97	0.92
B3	10.28	12.16	39.22	39.89	1.88	0.67

Table 10 : Exact Girder Length (G) with Splicing Zone (Z) for the Analyzed 150m Continuous Girder

G-1 m	Z-1 m	G-2 m	Z-2 m	G-3 m	Z-3 m	G-4 m	Z-4 m	G-5 m	Z-5 m	G-6 m	Z-6 m	G-7 m	Total m
10.575	1.11	28.95	0.31	21.438	0.97	28.985	0.92	21.66	1.88	28.435	0.67	9.875	150

b) Results for All Inverted-T Girder Analysis

Table 11 : Combination-1 SW+ SDL+ Lane Load (UDL) + Concentrated Load at mid support of the Bridge

Beam	Beam results		
	Moments (max) (kN-m)		
	Left node	Mid point	Right node
G1	4256.560	-2611.447	0.378
G2	0.378	-3884.87	0.372
G3	0.372	-2628.86	4181.164

Table 12 : Combination -2 SW+ SDL+ Lane Load (UDL) + Concentrated Load at Edge Support of the Bridge

Beam	Beam results		
	Moments (max) (kN-m)		
	Left node	Mid point	Right node
G1	4243.470	-1834.78	11.234
G2	11.234	-1863.87	12.976
G3	12.976	-1843.67	4190.456

Table 13 : Combination-3 SW+ SDL + Lane load (UDL) + HS 20-44 truck loading at Interior Girder

Beam	Beam results		
	Moments (max) (kN-m)		
	Left node	Mid point	Right node
G1	4422.370	-2045.236	0.487
G2	0.487	-4308.354	0.479
G3	0.479	-2067.784	4410.657

After analysis using STAAD Pro and checking deflection for different sections, finally we can conclude that different sections can be used for making continuous span by the technique of splicing at the erection site.

The inflection point due to self weight and superimposed dead load was checked by different bridge live load cases. After doing the analysis for different load cases, we found that inflection points were varied due to different loading position. The variation of

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the position of lane loading and truck loading effectively changed the location of inflection point. From the above findings the bending moment of bridge is reduced gradually by finite element plate analysis. If we use false box technique then we get the reducing bending stress benefit and reduced bending stress can give reduce bending moment which gives the lighter section. For this reason, deflection due to dead load is small and the live load deflection is reduced by pre-stressing of cross girder.

The pseudo box (false box) and splicing technique can be effectively practiced in the world where the box girder is most costly. Considering the socio-economic condition this technique for bridge construction is economic.

c) Merits of Pseudo Box Bridge Using Inverted-T Girder and Spliced Technique

There are two types of benefit using splice and pseudo box girder. These are

i. *Construction Benefit*

Where scaffolding for long time is not permitted then pseudo Box Bridge and splicing technique can be used for construction of bridges which is less time consuming at site work. That's why less number of workers will be required. Spliced girder segments are smaller than a full girder having a length of 50m. Also handling stress of the inverted-T girder is small than the actual box section, which can be transported easily from the factory to site and also easier to erect to their final location. We can reduce traffic hazards during the construction.

ii. *Structural Benefit*

To tell about the structural benefits about splicing technique at first we can highlight about the section of the girder. For false box technique bending stress is reduced, by the reduction of bending stress the bending moment is also reduced. Reduced bending moment can give reduced section which is lighter. For this reason, deflection due to dead load is small and the live load deflection is reduced by pre-stressing of cross girder.

iii. *Demerits of Pseudo Box Bridge Using Inverted-T Girder and Spliced Technique*

Principle demerits of using continuous girder by inverted-T girder and splicing technique are given below-

- We assumed all supports are not allowed to be settled. This is uncertain and need to be researched more about soil settlement.
- Experienced and skilled workers are needed but not available in our country.
- Analysis should be done carefully to detect the inverted-T section and spliced zone.
- As it is post-tensioned pre-stressing method accuracy must be maintained.

IV. Conclusion

The analysis of 750m continuous girder has been performed for two lanes 15 spans of 50m each. Objective is the beneficial using of pre-cast girder for long span bridges by pre-stressed pseudo Box Bridge using inverted-T girder and splicing technique. This analysis is done only for the vertical loadings. Analysis is fully performed by the STAADpro 2006 software to find out the moment, shear, and deflection of the structure specially the inflection zone for joining the inverted-T girders actually. With some limitations pre-stressed pseudo box using inverted-T girder and splicing technique can be applied in practical field. This technique for bridge and flyover construction is more economic and less time consuming. We hope that for our country pseudo box using inverted-T girder and splicing technique will be applied and practiced. To get the benefits both construction and structural this technique will be helpful. Bangladesh is a land of river, agricultural and flood affected country. Navigation clearance and hydraulic criteria (100year flood discharge) must be counted. That's why this technique should be practiced by the engineers.

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1. (http://en.wikipedia.org/wiki/Girder).
2. (Design of pre-stressed concrete structures, T. Y. Lin, page- 218).
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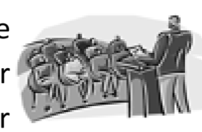

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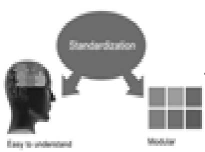

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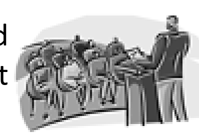

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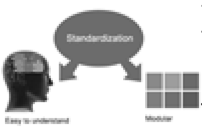

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27. Refresh your mind after intervals: Try to give rest to your mind by listening to soft music or by sleeping in intervals. This will also improve your memory.

28. Make colleagues: Always try to make colleagues. No matter how sharper or intelligent you are, if you make colleagues you can have several ideas, which will be helpful for your research.

29. Think technically: Always think technically. If anything happens, then search its reasons, its benefits, and demerits.

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Key points to remember:

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Final Points:

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- Reason of the study - theory, overall issue, purpose
- Fundamental goal
- To the point depiction of the research
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- Significant conclusions or questions that track from the research(es)

Approach:

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- Center on shortening results - bound background information to a verdict or two, if completely necessary
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- Exact spelling, clearness of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else

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- Explain the value (significance) of the study
- Shield the model - why did you employ this particular system or method? What is its compensation? You strength remark on its appropriateness from a abstract point of vision as well as point out sensible reasons for using it.
- Present a justification. Status your particular theory (es) or aim(s), and describe the logic that led you to choose them.
- Very for a short time explain the tentative propose and how it skilled the declared objectives.

Approach:

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- If use of a definite type of tools.
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- Simplify - details how procedures were completed not how they were exclusively performed on a particular day.
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The page length of this segment is set by the sum and types of data to be reported. Carry on to be to the point, by means of statistics and tables, if suitable, to present consequences most efficiently.You must obviously differentiate material that would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matter should not be submitted at all except requested by the instructor.

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- Sum up your conclusion in text and demonstrate them, if suitable, with figures and tables.
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- Present a background, such as by describing the question that was addressed by creation an exacting study.
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- Try to present substitute explanations if sensible alternatives be present.
- One research will not counter an overall question, so maintain the large picture in mind, where do you go next? The best studies unlock new avenues of study. What questions remain?
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	A-B	**C-D**	**E-F**
Abstract	Clear and concise with appropriate content, Correct format. 200 words or below	Unclear summary and no specific data, Incorrect form Above 200 words	No specific data with ambiguous information Above 250 words
Introduction	Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited	Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter	Out of place depth and content, hazy format
Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

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