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Assessment of Stability

The Role of Socio-Economic

Highlights

The Environmental Economics

Political Forces on Urban Planning

Discovering Thoughts, Inventing Future

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Assessment of Stability of Social-Ecological-Economic System of the Region

By V.V. Dmitriev & A.G. Osipov
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Abstract- The relevance of the research is conditioned by the need to develop the theory and practice of integral assessment of the state and emergent properties of complicated natural and social systems, with the use of modern methods of evaluation. The article deals with assessment of stability of the social-ecological-economic system (SEES), being its integrative (complex, emergent) property influencing the "quality of life" of the population. The authors, analyzing a regional SEES, characterize it by the ability to retain its properties and mode parameters in case of external influence on the system or its intra-system changes affecting the "quality of life" of the population. Tver region of the Russian Federation was taken as a model object. To assess the stability, the authors devised the following scenarios of impact on each of the subsystems of a particular regional SEES: 1 - hypothetical aggravation of the ecological situation in the region by 10, 20, 30%; 2 - hypothetical aggravation of the economic situation in the region by 10, 20, 30%; 3 - hypothetical aggravation of social conditions in the region by 10, 20, 30%; 4 - hypothetical aggravation in all subsystems simultaneously by 10, 20, 30%.

Keywords: social-ecological-economic system, integral assessment, stability, quality of life.

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Assessment of Stability of Social-Ecological-Economic System of the Region

V.V. Dmitriev [α] & A.G. Osipov [σ]

Abstract- The relevance of the research is conditioned by the need to develop the theory and practice of integral assessment of the state and emergent properties of complicated natural and social systems, with the use of modern methods of evaluation. The article deals with assessment of stability of the social-ecological-economic system (SEES), being its integrative (complex, emergent) property influencing the "quality of life" of the population. The authors, analyzing a regional SEES, characterize it by the ability to retain its properties and mode parameters in case of external influence on the system or its intra-system changes affecting the "quality of life" of the population. Tver region of the Russian Federation was taken as a model object. To assess the stability, the authors devised the following scenarios of impact on each of the subsystems of a particular regional SEES: 1 - hypothetical aggravation of the ecological situation in the region by 10, 20, 30%; 2 - hypothetical aggravation of the economic situation in the region by 10, 20, 30%; 3 - hypothetical aggravation of social conditions in the region by 10, 20, 30%; 4 - hypothetical aggravation in all subsystems simultaneously by 10, 20, 30%. Further, in the scenarios 5 – 8, twofold aggravation of the situation takes place - alternately in all of the above subsystems and in all subsystems simultaneously. The integral indicators of quality of life of the population were calculated for all 8 scenarios - for the first (within the subsystems) and second (between the subsystems) levels of convolution of the indicators. The results of assessment of the environmental quality and the quality of social life are presented for the years 2003 and 2013. At the first stage, the linear character of changes, with equal weighting of the estimation parameters within the three subsystems (environmental, economic, social) and between them was taken into account. The ecological subsystem included 8 evaluation parameters; the economic subsystem - 5; the social subsystem - 5. These parameters were selected from the website of the Russian Federal State Statistics Service ("The Russian Regions" reports). The major objective of the research was identification of situations in which SEES, upon assigned impact on it, will not be able to maintain its properties and mode settings and will shift to another class, both in individual subsystems and within the system as a whole. The condition of the system and the "quality of life" of the population was assessed for 5 classes (I-high; II-above the average; III-average; IV-below the average; V-low), specific for it in 2013. All the changes in the scenarios were realized against the background of 2013.

Keywords: social-ecological-economic system, integral assessment, stability, quality of life.

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I. Introduction

In the recent years the interest in the problem of formation of an objective system of indicators of public well-being and sustainable development has been shown by governments of many European countries, the PRC, the USA, Japan.

The relevance of the research is conditioned by the need to develop the theory and practice of integral assessment of the state and emergent properties of complicated natural and social systems, with the use of modern methods of evaluation.

The article deals with assessment of stability of the social-ecological-economic system (SEES), being its emergent property. The conditional formula of such system is presented by us thus: socio-system = biocenoses + physico-geographic environment (biotopes) + population + economy + culture + politics [1].

Let us dwell on the key point of our previous publications: a multi-criterion assessment of the state of the system reveals incomparability of the obtained assessments or ambiguities in the assessment of the state of an SEES. A measure of proximity to the "benchmark" by an aggregate of assessment criteria for a number of years reflects the researcher's idea of the degree of the well-being of the SEES. These ideas depend on axiological provisions incorporated into the methodology and the axiometric ideas on the assessment scales of the assessment criteria. A stable system is a system that retains its properties and mode parameters in case of external or internal influence on it. One can also consider the well-being of an SEES and high or low quality of life of the population in SEES's of different scales. But even here, stability, as an emergent property of the system as a whole, can form the axiological bases of assessment of another complex property, in our case, of its well-being. In this case a situation arises when "stability" and "well-being" in a number of publications are considered almost as synonyms, or a term "health of a system" is introduced, for example. A stable system is considered in the first turn a "healthy", or "good" one [2], and if the stability is impaired, such system loses its initial (healthy) status.

II. Materials and Methods

The paper characterizes the state of a regional SEES through the system's ability to retain its properties

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and mode parameters in case of external influence on the system or of internal, intra- systemic changes characterizing the quality of life of the region's population. Proceeding from the definitions of life quality, the basic objective of integral assessment may be the identification of an aggregate of natural, social, and economic conditions assuring to a greater or lesser degree human health, personal and public, and his/her needs, i.e. conformity of a healthy person's life environment to his/her needs [3].

Tver region of the Russian Federation was taken as a model object to an analysis of SEES stability. The common basis for constructing of integral indicators is described by us in a sufficiently large amount of publications, including the papers [2, 3].

Let us consider the following scenarios of impact on each of the SEES subsystems: - hypothetical aggravation of the ecological situation in the region by 30%; 2 - hypothetical aggravation of the economic situation in the region by 30%; 3 - aggravation of social conditions in the region by 30%; 4 - hypothetical aggravation of the situation in all subsystems simultaneously by 30%. Further, in the scenarios 5 - 8 , multiple aggravation of the situation takes place alternately in all of the above subsystems and in all subsystems simultaneously. Let us calculate the integral indicators of quality of life of the population for all 8 scenarios - for the first (within the subsystems) and second (between the subsystems) levels of convolution of the indicators. Let us present the results of assessment of the environmental quality and the quality of social life for the years 2003 and 2013. At this stage let us take into account the linear character of changes with equal weighting of the parameters within the three subsystems (environmental, economic, social) and between them, in the analysis let us consider only the results of the options with 30% and twofold aggravation of the situation within the units and between the units against the background of 2013.

Let us include into the ecological subsystem 8 estimation parameters: 1- emissions of pollutants into the atmospheric air from stationary sources (ths tons); 2- entrapment of atmospheric pollutants from stationary sources (ths tons); 3- use of fresh water (mln cubic meters); 4- volume of circulating and subsequently utilized water (mln cubic meters); 5- forest regeneration (ths hectares); 6- fertilizer application per one hectare of agricultural crops in agricultural entities (tons); 7- discharge of contaminated drain waters into surface water bodies (mln cubic meters); 8- generation of production and consumption waste (ths tons).

Into the economic subsystem let us include 5 estimation parameters: 1- population numbers (assessment by end of year; ths persons); 2- number of unemployed (ths persons); 3- per capita monetary income of population per month (rubles); 4- population numbers with monetary incomes below living wage (in % of total population); 5- number of enterprises and organizations (pcs.).

Into the social subsystem let us include 5 estimation parameters: 1- life expectancy at birth (number of years, all population); 2- number of registered crimes per 100,000 people; 3- number of visits of museums per 1000 people; 4- number of hospital beds total, ths; 5- number of preschool educational institutions.

Let us take all indicators from Rosstat website ("Regions of Russia" compilations) for 2003 and 2013. The basis objective of the research will be convolution of the indicators at the first and second levels and identification of situations in which SEES fails to retain its properties and mode parameters at the prescribed hypothetical influence on it in individual subsystems and the system as a whole. The state of the system and quality of life of population in the region was estimated for 5 classes (I - high; II – above average; III - average; IV – below average; V - low) in which it was in 2013. The proximity of the integral indicator to 0.0 evidences high quality of life of population, the proximity to 1.0 evidences low quality.

The analysis of the obtained results has allowed the following basic conclusions to be drawn:

1. In 2003 quality of people's life in the region at the second level of convolution was characterized by the value 0.64 of the consolidated indicator (IV class middle); in 2013 – 0.57 (border of classes III-IV). The change in quality of people's life, as follows from the estimates, was mostly influenced by the economy (the integral indicator for the subsystem was reduced by 18%). The contribution of the social subsystem amounted to 6.7%, of the ecological one 8.9%. In general, from 2003 to 2013 the improvement of the social and ecological conditions was identified.
2. When planning scenarios of aggravation of the ecological situation at the first stage of convolution, the multidirectionality of the parameters was taken into account upon the prescribing of the characteristics of the ecological subsystems (4 characteristics have a direct relation to the assessment of life quality and 4 have a reverse relation). The borders of the classes of the integral indicator of the ecological subsystem for class III: 0.37-0.56; for class IV: 0.56- 0.77. The aggravation of the ecological situation only (only the parameters of the ecological subsystem) by 30% in all 8 parameters has not changed the class of the ecological state of the system. The integral indicator of the ecological subsystem has grown by 7.3% (it was 0.41, it has become 0.44, table 1).

At the second level of convolution, by the value of the consolidated indicator, the state of SEES and life of population transferred from a borderline situation

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between classes III-IV in 2013 to class IV (0.58). The change is generally insignificant (1.8%), but it characterizes the transition of the system into a more senior class and therefore should be mentioned, the system in general at 30% of hypothetical influence expressed in a change of the parameters of the ecological subsystem was unable fully its properties and mode parameters and thus was susceptible to the ecological situation. These calculations have confirmed the conclusion obtained by us earlier, in the North West of the Russian Federation, that an improvement of the environmental quality by less than 30% does not result in changing the class of people's life quality by a consolidated indicator [3,4].

The twofold aggravation of the ecological situation only by all 8 parameters (table 1) changes the value of the integral indicator of the ecological subsystem by 17% (0.48, class III; it was 0.41, class III) and brings life quality in this subsystem closer to class IV, class interval being 0.56-0.77). By the value of the consolidated indicator of life quality the absolute value is noted to have increased by 3.5%. The value of the consolidated indicator is characterized by class IV (0.59 left border of class IV, it was 0.57, the middle of the class). The borders of class IV for the consolidated indicator: 0.56-0.79.

3. When planning the scenarios of aggravation of the economic situation only, the multidirectionality of parameters upon the prescribing of the characteristics was also taken into account (2 characteristics have a direct relation to the assessment of life quality and 3 have a reverse relation).

The aggravation of the economic situation only by 30% in all 5 parameters has changed the value of the integral indicator of the economic subsystem by 6.8% (it was 0.59- the border of class III-IV, it has become 0.63 – class IV, closer to the left border, table 2), however, by the value of the consolidated indicator the class of life quality has changed insignificantly, by 1.8% (0.57 in 2013 and 0.58 at 30% aggravation).

The twofold aggravation of the economic situation only in all 5 parameters of the economic subsystem has brought about an increase in the integral indicator of the unit by 20% (0.71, class IV; it was 0.59) with the width of the class interval 0.59-0.81. This has not changed the class of the integral indicator, but has brought the life quality estimated by the economic subsystem closer to class V. By the value of the consolidated indicator, in this case, life quality has aggravated by 7% and was characterized by the value of the consolidated indicator 0.61 (class IV), it was 0.57 (the border of classes III-IV) with the width of the interval of the consolidated indicator of class IV 0.56-0.79.

4. When planning scenarios of aggravation of the situation in the social sphere only, the multidirectionality of the parameters upon the prescribing of the characteristics was also taken into account (1 characteristic has a direct relation to the assessment of life quality and 4 have a reverse relation).

The aggravation of the situation in the social sphere only by 30% in all 5 parameters (table 3) has changed the value of the integral indicator of the subsystem by 18.6% (it was 0.70 - class IV, it has become 0.83 – class V, closer to the left border with the width of the interval of class V 0.80-1.00), however, at the value of the consolidated indicator, life quality has changed insignificantly, by 7% (0.57 in 2013 and 0.61 at 30% aggravation of the social conditions).

The twofold aggravation of the situation in the social sphere only in all 5 parameters (table 3) changes the class of the integral indicator of the social subsystem by 34.3% (0.94, class V, it was 0.70). By the value of the consolidated indicator the quality of people's life has gone down by 21% (0.69, class IV, it was 0.57 – the border of classes III-IV) with the width of the interval of the consolidated indicator of class IV 0.56-0.79.

In general, one can observe that the most sensitive subsystem was the system of social conditions. For it the highest increase of the influence effect has been noted, both on separate subsystems and in general on the socio-ecological-economic system (a consolidated assessment). With small negative changes the ecological and economic parameters have almost the same changes, both on the first level of convolution and on the second. It is noticeable that after the 30% aggravation the consolidated assessment is influenced more by the economic factors.

5. Of interest also is the simultaneous taking into account of possible reduction in life quality in all subsystems simultaneously. For this, the consolidated indicator of life quality was calculated with 30% aggravation of the conditions in all subsystems simultaneously compared to 2013. In this case the consolidated indicator is equal to 0.63 (IV*m*). Prior to the changes it was 0.57 (the border of classes III-IV). In percentage terms the changes amount to 10.5%. In virtue of the prescribed linear nature of the changes in the characteristics at first approximation this value corresponds to the total of the percentages of the changes by separate subsystems: 1.8+1.8+7.0.

With the twofold reduction in life quality in all subsystems simultaneously we obtain the value of the consolidated indicator 0.71 (IV*r*). It was 0.57 (the border of classes III-IV). In percentage terms the changes have amounted to 24%. Thus, with the twofold reduction in the parameters we obtain an almost linear increase in

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the consolidated indicator and transition of life quality from the borderline value between classes III and IV into class IV (closer to the border with class V).

6. It follows from conclusions 1-5 that the hypothetical 30% change of the situation in one of the subsystems toward aggravation of life quality compared to 2013 (table 4) brings about an increase in the consolidated indicator for the ecological subsystem by 7.3%, for the social subsystem by 18.6%, for the economic subsystem by 6.8%. By the value of the consolidated indicator with 30% change of the situation in all subsystems simultaneously there is 10.5% increase in the consolidated indicator. This increase causes reduction in life quality by about half of the class.

The twofold change of the situation in one of the subsystems toward aggravation of life quality compared to 2013 (table 4) results in an increase in the consolidated indicator in the ecological subsystem by 17%, in the social subsystem by 34%, in the economic subsystem by 20%. By the value of the consolidated indicator with the twofold change of the situation in all subsystems simultaneously there is 24% increase in the consolidated indicator. This increase causes reduction in life quality by about one class.

III. Conclusion

The results of the integral assessment have been analyzed. The quantitative characteristics of the state of the region in 2003 and 2013 have been obtained. In a series of experiments the influences have been identified under which a system transitions into another state class and therewith loses stability. The authors are aware that the taking into account of the non-linear nature of changes and of the uneven weightage of the estimation parameters within subsystems (ecological, economic, social) and between them can change the obtained results. As our experience has shown, however, these changes will not result in any strong differences or fundamental changes. In the same with one can calculate a change in the integral indicator by time for different years or by space in the basis of natural data or the Rosstat data. In more complex examples taking into account disparate weightiness of parameters within subsystems and between them, the non-linear nature of relations; incomplete, inaccurate, and non-numerical information on the assessment priorities, also multilevel convolutions of information are introduced. The weighting factors are specified on the basis on information deficiency models. The comparison of the state of the systems on the integral basis enables also quantitative assessment of spatio-temporal particulars of their dynamics and the degree of their transformation. As the "admissible limit" value of the consolidated indicator a value can be recommended obtained on the basis of the "convolution" of admissible limit (critical) values of the initial parameters on the borders of the classes, if they are known.

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Table 1: Scenarios for aggravation of the ecological situation and the environmental quality in the region

Unit	Estimation parameters	Relation	2003	2013	Aggravation of situation of 2013 by 30%	Rated value of aggravation by 30%	Twofold aggravation of situation of 2013	Twofold rated value of aggravation of situation
Ecological	1. Emissions of pollutants into atmospheric air from stationary sources (ths tons)	Direct	51	60	78	0,031	120	0,048
	2. Entrapment of atmospheric pollutants from stationary sources (ths tons)	Reverse	20	19	14,6	0,998	9,5	0,999
	3. 3. Use of fresh water (mln cubic meters)	Reverse	1283	1399	1076	0,838	700	0,894
	4. Volume of circulating and subsequently utilized water (mln cubic meters)	Reverse	2154	6382	4909	0,535	3191	0,697
	5. 5. Forest regeneration (ths hectares)	Reverse	13,9	11,1	8,5	0.958	5,55	0.972
	6. Fertilizer application per one hectare of agricultural crops in agricultural entities (tons)	Direct	9,4	7,3	9,5	0,063	14,6	0,097
	7. Discharge of contaminated drain waters into surface water bodies (mln cubic meters)	Direct	77	90	117	0,078	180	0,120
	8. Generation of production and consumption waste (ths tons)	Direct	595	1064	1383	0,001	2128	0.001
	Integral indicator for ecological unit / class of quality of people's life		**0,45 (III)**	**0,41 (III)**		**0,44 (III)**		**0,48 (III)**

Table 2: Scenarios for aggravation of the economic situation in the region

Unit	Estimation parameters	Relation	2003	2013	Aggravation of situation of 2013 by 30%	Rated value of aggravation by 30%	Twofold aggravation of situation of 2013	Twofold rated value of aggravation of situation
Economic	1. Population numbers (assessment by end of year; ths persons)	Reverse	1444	1325	1019	0,920	662,5	0,949
	2. Number of unemployed (thspersons)	Direct	50,9	38	49.4	0,299	76	0,461
	3. Per capita monetary income of population (per month; rubles;)	Reverse	3021	19106	14697	0,801	9553	0,881
	4. Population numbers with monetary incomes below living wage (in % of total population of the constituent entity)	Direct	39,0	11,8	15,34	0,170	23,6	0,262
	5. Number of enterprises and organizations	Reverse	42708	35614	27395	0.978	17807	0,986
	Integral indicator for economic unit		**0,72 (IV *m*)**	**0,59 (III-IV)**		**0,63 (IV /)**		**0,71 (IV *m*)**

Note. There are specified in the table: l is closer to the left border of the class; m is middle of the class; r is closer to the right border of the class.

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Table 3: Scenarios for aggravation of the social conditions in the region

Unit	Estimation parameters	Relation	2003	2013	Aggravation of situation of 2013 by 30%	Rated value of aggravation by 30%	Twofold aggravation of situation of 2013	Twofold rated value of aggravation of situation
Social	1. Life expectancy at birth (number of years, all population)	Reverse	61,53	68,13	52,4	0,931	34,1	1,000
	2. Number of registered crimes per 100,000 people	Direct	1970	1515	1969,5	0,657	3030	1,000
	3. Number of visits of museums per 1000 people	Reverse	343	342	263	0.812	171	0,878
	4. Number of hospital beds total, ths	Reverse	18,5	13,3	10,2	0,915	6,65	0,945
	5. Number of preschool educational institutions	Reverse	645	487	374,6	0,822	243,5	0.884
	Integral indicator for social unit		**0,75 (IV)**	**0,70 (IV)**		**0,83 (VI)**		**0,94 (V *r*)**

Note. There are specified in the table: l is closer to the left border of the class; m is middle of the class; r is closer to the right border of the class.

Table 4: Generalization of the results on the hypothetical reduction in quality of people's life in Tver region in relation to 2013

Aggravation of situation in % /Units	Ecological	Economic	Social
	30% reduction	30% reduction	30% reduction
For unit (level 1 of convolution)	7,3	6,8	18,6
For consolidated assessment (level 2 of convolution)	1,8	1,8	7,0
	twofold reduction	twofold reduction	twofold reduction
For unit (level 1 of convolution)	17	20	34,3
For consolidated assessment (level 2 of convolution)	3,5	7,0	21

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An Introductory Note on the Environmental Economics of the Circular Economy

By Mikael Skou Andersen

Abstract- This paper provides an introduction to some of the fundamental principles and approaches in envi- ronmental economics which are of significance to achieving an integrated sustainability science. The concept of a circular economy, introduced by the late David Pearce in 1990, addresses the interlink ages of the four economic functions of the environment. The environment not only provides amenity values, in addition to being a resource base and a sink for eco- nomic activities, it is also a fundamental life-support system. Environmental economists have suggested that, taking these four functions as an analytical start- ing point, unpriced or underpriced services should be internalised in the economy. In Europe significant ad- vances have been achieved in the pricing of externali- ties by means of truly interdisciplinary analysis which accounts in detail for the environmental consequences. The monetary estimates reached as a result of such interdisciplinary research are gradually being applied to the economic analysis of environmental policy pri- orities. Although such figures provide only a partial and incomplete picture of the environmental costs at stake, they support and inform the analysis of the vir-tues of a circular economy for individual resources as well as for sustainability as a future trajectory.

Keywords: *circular economy environmental economics externalities sustainability.*

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An Introductory Note on the Environmental Economics of the Circular Economy

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I. Introduction

The concept of a circular economy – currently widely promoted in Asia – has its conceptual roots in indus- trial ecology, which envisions a form of material sym- biosis between otherwise very different companies and production processes. Industrial ecology emphasises the benefits of recycling residual waste materials and by-products through, for example, the development of complex interlinkages, such as those in the renowned industrial symbiosis projects (see Jacobsen 2006). However, in more general terms, it promotes resource minimisation and the adoption of cleaner technologies (Andersen 1997, 1999).

In industrial ecology, it is implied that a circular economy will be beneficial to society and to the economy as a whole. Benefits will be obtained, not only by minimising use of the environment as a sink for residuals but – perhaps more importantly – by minimising the use of virgin materials for economic activity. Intuitively, the potential benefits seem straightforward, but it is important to stress that the perspective prevailing within the circular economy approach is, in fact, based on physical rather than economic observations.

The assumed benefits are based on the fundamental observation that the loss of material residuals, in physical units, is minimised. But how far should society go in the recycling of materials? While the first and most straightforward recycling options provide evident benefits, once the recycling road is embarked upon, the subsequent benefits gradually become more and more difficult to achieve. It has to be acknowledged that at some stage there will be a cut-off point where recycling will become too difficult and burdensome to provide a net benefit. A circular economy cannot promote recy- cling in perpetuity.

Many adherents of the circular economy approach are strong proponents, on environmental and ethical premises, of material reuse and recycling. However, in a market economy (and in some planned economies as well), the prices of materials and natural resources will be too low and will mainly reflect the costs associated with mining and short-term values, but not with depletion nor the environmental costs. In such cases, only a limited range of circular options will make sense from the perspective of company managers. It can be argued that if companies are rational and profit-seek- ing, the recycling and reuse options should already have been realised. In a conventional capitalist econ- omy, recycling will be undertaken only where it is desirable from a private economic viewpoint.

Decision-makers responsible for public policy-mak- ing need to transcend such narrow perspectives and institute mechanisms that secure that recycling and re- use takes place where it is socially desirable and effi- cient. As a first step, it is necessary to analyse more carefully from a socio-economic perspective how cir- cular economy principles can provide net benefits. Environmental economics offers an analytical approach that can be of considerable help in identifying which material streams and which recycling options provide the greatest benefits to the economy – if circular rather than open-ended principles are introduced. Environ- mental economic analysis in public policy-making pre- sumes, in practice, an in-depth understanding and description of the environmental consequences of vari- ous choices, thereby making the analysis interdisciplin- ary in nature. Environmental economics also offers the basis for introducing ''externality adders'' to market prices in the form of environmental taxes and charges,

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so that prices can reveal the true situation, thereby allowing market actors to take account of the real costs in their mutual transactions.

This paper provides an introduction to the approach of environmental economics and indicates its potential for achieving a sound and efficient circular economy.

II. A Circular Economy

The conventional perception of the economic system is that it is open-ended. Production, P, is aimed at pro- ducing consumer goods, C, and capital goods, K. In turn, capital goods produce consumption in the future. The purpose of consumption is to create ''utility'', U, or welfare. Sometimes natural resources, R, are also considered within this linear perspective (Fig. 1).

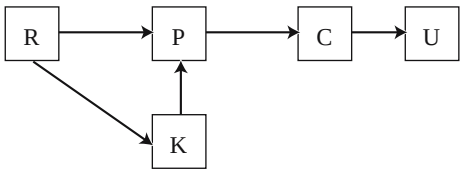

Fig. 1: The conventional open-ended economy. P production, C consumption, K capital goods, U utility, R natural resources

The open-ended system converts to a circular system when the relationship between resource use and waste residuals is considered. The first law of thermodynamics states that total energy and matter remains constant in a closed system (the planet can be regarded as such a closed system). The implication is that the amount of waste generated in any one period must be equal to the amount of resources depleted. Capital goods can function as a temporary embodiment of resources, but when consumed, they are converted to waste somewhere in the environmental system. Energy cannot be destroyed, but it can be converted or dissipated. However, due to the stocks of natural resources embodied in capital goods, in actual practice, the relationship between resource use and waste in any one period is slightly more complicated.

In the open-ended system, the box r represents recycling. Some of the waste can be converted back to resources. In this way the economy becomes circular. Not all waste is recycled, however – partly due to missed opportunities and partly due to some basic physical laws (Fig. 2).

To understand why this is the case, we need to consider the second law of thermodynamics. The term entropy describes how well matter and energy is organised; the more organised and uniform these are, the lower the entropy. However, as resources are extracted from clean ores and circulated through the economy, their entropy increases. While this is especially evident for fossil fuels that end up in the atmosphere as CO2 molecules, increasing entropy applies to most metals as

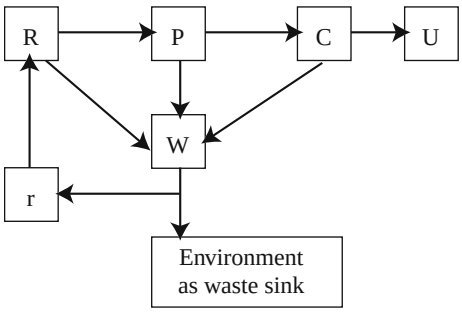

Fig. 2: The simplified circular economy. r Recycling, W waste

well. The deterministic thesis of Georgescu-Roegen (1971) states that the degree of entropy is bound to increase as humans extract more and more matter and energy for the economy. Circulating matter and energy would reduce the need for new inputs to the economic system and help delay the increasing entropy.

III. Four Economic Functions of the Environment

As a precursor to the environmental economic analy- sis, we begin by briefly considering the functions of the environment as seen from the perspective of econom- ics (cf. Pearce and Turner 1990). The environment clearly has values in its own right, but in neoclassical environmental economic analysis an anthropocentric approach is applied, with emphasis on the utility of the environment for humans, as measured in terms of economic welfare.

From this perspective the environment can be acknowledged as fulfilling four basic welfare economic functions: (1) amenity values; (2) a resource base for the economy; (3) a sink for residual flows; (4) a life- support system. Pearce and Turner (1990) present these four functions and their interlink ages within the context of ''The circular economy'' in their textbook on environmental economics, but the conceptual and theoretical understanding here differs (compare with above) fundamentally from that of industrial ecology. The circular economy from the environmental economics perspective is based on a material balance principle (Kneese et al. 1970), which implies that all material flows need to be accounted for, although it will be the economic values, not the physical flows, that guide their management.

Amenity values are the pleasures that the environ- ment provides directly to humans without interference from the economic system; examples include the beauty of landscapes or the existence value of partic- ular species. Even if these landscapes or species have never been observed or experienced

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directly, such as whales or the panda, humans may accord the species some value in relation to human welfare and will experience some loss if conditions for the species deteriorate.

Secondly, the environment provides a resource base, which functions as an input for the economy, both in terms of renewable and non-renewable resources. Many biological resources are renewable and can be harvested for economic purposes with no or limited impact, as long as the harvest does not exceed the annual yield. Fish stocks are a good example of this. More problems arise in the case of non-renewable resources (e.g. fossil fuels) where the physical stock, by definition, will be depleted as the resources are brought into the economic system. It is important to under- stand, however, that depletion is possible both for non- renewable and renewable resources.

Thirdly, the environment functions as a sink (waste bin) for the residuals of economic activity, whether the emissions are waterborne, airborne or solid. The environment has a certain assimilative capacity for receiving residuals from the economic system, but once the assimilative capacity is exceeded, environmental damage begins to surface. Human beings, themselves, form part of the environment and exceeding the assimilative capacity of the human body with residuals from, for instance, air pollution or toxins is tradition- ally a case for concern for human health, just as sur- face-water pollution gives rise to more general environmental concern.

Finally, the environment functions as a life-support system, both for humans and non-humans. This func- tion acknowledges the inherent biological character of the environment and that the life-support function can be influenced as a result of economic activities.

The four economic functions of the environment are mainly analytical categories. There are interactions among them, however, which require a further sophistication of the environmental economic analysis. The life-support function for biological systems can, for instance, be impaired as a result of the environment being used excessively as a sink for residuals. This aspect has been addressed by the specific concept of ecological utilisation space (cf. Opschoor and Weter- ings 1994).

Figure 3 shows the linkages between the four eco- nomic functions of the environment – and underlines the significance of the circular economy. Residuals that are discharged to the environment do not only have the potential to cause harm (if waste exceeds assimilative capacity) by affecting amenity values and the life- support function, they have also been lost from the point of view of the economic system. This loss of residual materials from the economic system can be postponed for non-renewable resources if a circular economy that promotes recycling and reuse is insti- tuted.

However, there is the additional issue of minimisa- tion. Some environmental economists argue that the input of materials and resources to the economy should be kept at a minimum and that a minimisation approach is a necessary prerequisite to the circulation of residuals. The argument for reducing the scale of material circulation lies with the second law of ther- modynamics and the concept of entropy.

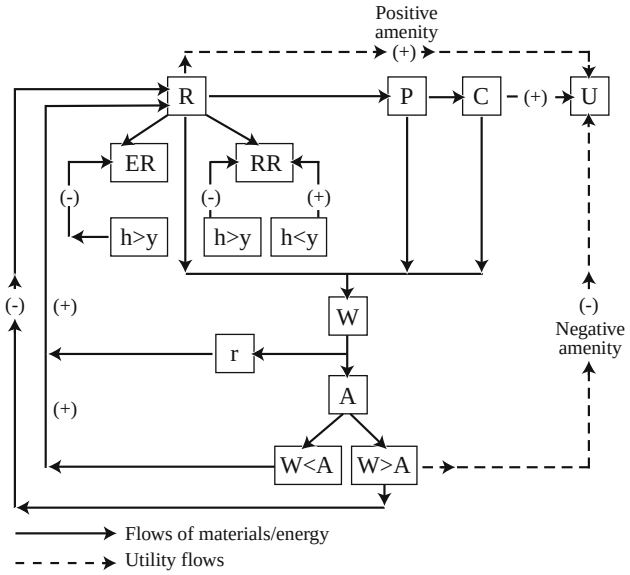

Fig. 3: The circular economy. Source: Pearce and Turner (1990). P production, C consumption, K capital goods, U utility, R natural resources, r recycling, W waste, ER exhaustible resourc-es, RR recyclable resources, A assimilative capacity, h harvest, y yield

a) *Sustainable development and sustainable economic welfare*

Before examining how values can be attached to the economic services and disservices related to the envi- ronment, we need to consider briefly the implications associated with requirements for sustainable develop- ment with respect to the choice of economic approach. The UN's World Commission defines sustainable development as a trajectory where future generations are secured the same level of welfare as present living generations. The implication of this approach, as seen from an economics standpoint, is a requirement for constant consumption or, phrased in a slightly more abstract manner, constant utility. In order to maintain annual yield at a constant level, there will be, in the absence of technological progress, a requirement for the stock of environmental resources to be kept con- stant. Environmental resources should be managed in such a way that the future yield does not diminish and future generations will not be worse off. In this man- ner, environmental resources can be viewed as a bank account where the capital (deposited amount) remains constant so as to generate a steady stream of interest to live on.

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The requirement for constant yield and a constant stock of natural capital is restrictive. It has become customary to distinguish between strong and weak versions of sustainable development. Within the weak form of sustainability, the substitution of natural capital and other types of capital is allowed, such that the depletion of natural capital has to be compensated through savings in other types of capital, such as human capital or physical capital. While often regarded as a relaxation of the sustainability criteria, even this weaker definition of sustainability would be a challenge for many countries which do not have systems in place that are able to account for whether or not the extraction of fossil fuels is compensated through reinvestments in education (human capital) or infrastructure (physical capital). The strong version of sustainable development, which does not allow for substitution, is normally made less rigid so that focus is on the non-substitutability of certain types of critical capital.

The economic sustainability definition is usually associated with Hardwick's savings rule, which suggests that the rents from natural resource extraction should be reinvested in other types of capital and that the government should ensure this by instituting a tax on natural resource extraction so as to guarantee a sustainable level of savings. In the case of fossil fuels, Hartwick's savings rule implies that income from fossil fuel taxes would be reinvested in other types of capital and that these would yield a level of annual rent in the future similar to the present extraction of fossil fuels.

External effects

Pigou (1920) (predecessor to John Maynard Keynes at Cambridge) drew attention to the significance of mar- ket failures in terms of externalities in the economic system, including externalities such as environmental externalities. External effects occur wherever ''a transaction between A and B has unwanted, positive or negative, consequences for third party'', but Pigou's favourite example was impacts from pollution.

We can categorise such effects – in particular the negative external effects – in terms of the four economic functions of the environment and the economic concept of sustainability. Economic activities can hence:

- impact amenity values negatively;
- lead to excess resource extraction, i.e. depletion;
- cause harmful residual flows beyond the assimilative capacity of biological systems;
- reduce the regenerative capacity of life support systems.

External effects can also be positive, such as the nutrient effect of airborne nitrate in stimulating crop growth, but, on balance, the evidence suggests that the positive effects are of relatively minor importance as compared to the negative ones (cf. Holland et al. 1999).

In order to be able to estimate the optimal level of environmental controls, not only do the costs of intervention need to be known, but also some idea of the order of magnitude of the external effects to be reduced is needed. For this purpose, some estimates of the values of environmental goods are required as well as a good quantification of the environmental consequences of marginal changes in economic activity. The accounting of external effects requires a life cycle assessment (LCA)-based approach in order to take full account of the complex pathways involved. It also needs to be based on a valuation of environmental goods, preferably on revealing individual preferences for such goods by means of indirect or direct methods. It could be argued that a circular economy will turn negative external effects into positive ones by con- necting waste streams to possible beneficiaries. How- ever, in order to assess the benefits of this approach we would still need to account for the effects separately as
well as for the direct costs involved.

IV. Market Prices Reflecting External Costs

Once reasonable estimates are available for the external costs, it would be possible to internalise these in market transactions by introducing relevant environmental taxes and charges.

There are four main reasons why such an approach would be preferable.

First and from the purely economic perspective, the externality tax approach secures that the marginal costs of the external effects will be reflected in market prices, so that market actors will take account of these in their mutual transactions. The allocative efficiency will be improved if the environment is not a free commodity but has a price tag. Some external effects will persist, but as a price tag is now attached, the benefits of economic activity will need to exceed the social costs imposed. Producers may choose to employ more labour and ''less environment'' by, for example, promoting recycling and reuse activities.

Secondly, externality taxation will help improve abatement efficiency. Existing environmental regulations are often technology-oriented and prescribe uniform technological measures for all polluters, regardless of the specific opportunities for cost-effec- tive abatement in various industrial sectors and companies. If prices reflect the external costs, polluters will abate where measures can be introduced which are more cost-effective than paying the tax; conversely, they will choose to pay the tax where measures are too expensive.

Thirdly, externality taxation will often provide a continual incentive to develop new and cleaner technologies, which can in turn reduce impacts cost-effectively and lower the marginal abatement costs. Being

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granted a permit on the basis of administrative standards is a conventional negotiation process, whereas externality taxation embodies a dynamic market-based process. The relative success of Japan in sulphur abatement in the 1970s compared with other industrialised countries was caused not only by stringent standards but also by the health compensation levy, which provided an economic incentive akin to an externality tax (Matsuno and Ueta 2000).

Finally, the externality taxation approach allows for flexible adjustment. The individual company has more freedom to find its own solution, which can promote highly individualised solutions as recommended within the industrial symbiosis approach of the circular economy.

It is of course possible to introduce environmental taxes merely as an incentive to reduce pollution, but the crucial question remains how to justify the exact rates of such taxes. Baumol and Oates (1971) once suggested setting the rates of environmental taxes at a level sufficient to ensure the agreed standards accord- ing to the ''standard-pricing'' approach. However, the problem remains that it is far from certain that stan- dards will lead to a socio-economically efficient level of abatement. Standards are partly the result of a political process and may have been set either too low or too high from an environmental economic perspective. Baumol and Oates (1988) put forward their proposal in the absence of externality estimates and, in fact, did not include the standard-pricing approach in their subsequent textbook on environmental economics.

V. How to Account for External Costs

It follows from the above, that techniques to account for external costs will be needed to provide the right economic incentives to internalise the use of the environment in the economic system.

In recent years considerable advances have been made in developing methods to account for external effects. These advances have taken place primarily in the context of the Extern E research project series, financed by the European Union's Research Programmes. To begin with, these efforts were undertaken in cooperation between U.S. and EU research programmes, but since 1995 the efforts have been financed entirely by the EU.

ExternE has addressed the externalities of energy production and transport and has primarily focused on the effects related to the use of the environment as a waste repository for air pollution. Comprehensive progress has been accomplished in quantifying the impacts of air pollution on crops, forests, building materials as well as on human health. ExternE uses the impact pathway approach to trace the specific impacts of pollutants.

The main methodological challenge in accounting for external costs is that it is necessary to know the marginal contribution of a particular economic activity to the state of the environment. In the case of air pollution, one needs to know the contribution of, say, a particular power plant's emissions to the air pollutant concentrations in a particular area. Such changes in air pollution concentrations, and in subsequent exposures, can in fact be calculated by combining local and regional air pollution models. This is the first step in the impact pathway methodology of ExternE (Fig. 4).

Once the marginal changes in concentrations are known, the second step in the impact pathway is to calculate the number of people exposed. Geographical information systems (GIS) are used here to keep record of land-use and population densities, so that, for example, the number of persons exposed to air pollution is matched directly with the changes in air pollution exposure in specific parts of the geographical grid. In this way the analysis can capture the significance of potentially high exposures in areas with high population densities. The method is highly site specific in its accounting of the external effects, as both the emissions and the exposures are calculated according to the specific site in question.

The third step in the impact pathway assessment involves a screening of the scientific literature for dose- response functions of the effect endpoints. Dose- response functions describe how various entities will react to changes in exposures. Vegetation cover, for example, reacts to changes in air pollutant concentra- tions, as do humans. The medical literature is espe- cially rich on exposure-response functions. These functions are, at our current level of knowledge, often treated as linear, but there are important thresholds to consider, below which possibly no effects occur.

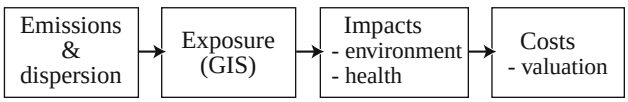

Fig. 4: The impact pathway chain (Holland et al. 1999). GIS Geographic Information System

The fourth and final step involves attaching unit values to the end-points of the impact pathway analysis. In the case of air pollution, the end-points comprise both mortality and morbidity effects for humans; the latter comprise work-loss days, cases of bronchitis, prevalence of asthma medication, hospital admittances, among others. The endpoints can be valued either with cost-of-illness figures or, if desired, with preference-based values based on contingent valuation surveys.

Table 1 provides an overview of figures for the externalities of air pollution arrived at in an analysis commissioned by the European Commission. The fig-

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ures differ between member states, not only because of differences in population densities but also because of differences in abatement technologies (e.g. in power plants). The difference between Belgium and Denmark for particulate matter smaller than 2.5 lm (PM2.5) is believed to reflect both of these factors.

It is important to emphasise that these figures are likely to increase if emissions occur in highly populated areas (e.g. in cities). In a city with 100,000 inhabitants, the externality estimate for PM2.5 is 33,000 €/t and for SO2, 6000 €/t. In a city with 0.5 million inhabitants, the estimates increase by a factor of 5. NOX remains constant as it is a regional pollutant with a greater dispersion than particulates and sulphates (the figures reflect European price levels and would differ for a region with other health sector costs and lower per capita income).

Table 1: Externality estimates for air pollutiona from stationary and mobile sources: background values (BeTa-tables, European Commission 2002)

Commission 2002				
€/tonne	SO_2	NO_x	PM2.5	VOCs
Austria	7,200	6,800	14,000	1,400
Belgium	7,900	4,700	22,000	3,000
Denmark	3,300	3,300	5,400	720
Finland	970	1,500	1,400	490
France	7,400	8,200	15,000	2,000
Germany	6,100	4,100	16,000	2,800
Greece	4,100	6,000	7,800	930
Ireland	2,600	2,800	4,100	1,300
Italy	5,000	7,100	12,000	2,800
Netherlands	7,000	4,000	18,000	2,400
Portugal	3,000	4,100	5,800	1,500
Spain	3,700	4,700	7,900	880
Sweden	1,700	2,600	1,700	680
UK	4,500	2,600	9,700	1,900
EU-15 average	5,200	4,200	14,000	2,100

a Values are expressed in lg/m³. NO_x, Nitric oxides; $PM_{2.5}$, particulate matter smaller than 2.5 lm; VOCs, volatile organic carbons

VI. Socio-Economic Analysis of the Circular Economy

The externality estimates can be used in the analysis of projects that are considered to improve the circular aspects of the economy. In the case of recycling, the potential benefits are basically comprised of three elements:

- the market value of the recycled materials;
- reduced burden from waste disposal (incineration or landfill);
- reduced burden due to reductions in extraction of virgin materials.

The two burdens will be site- and technology-spe- cific to some extent and can be assessed by means of the impact pathway method, taking into account the specific damages. It is necessary to take into account a wider set of emissions and environmental burdens than those mentioned in Table 1 as these are only examples of where methods exist to quantify externalities. In recent years, externality estimates have also been developed for heavy metals and certain toxic materials, whereas the main lacunae are for emissions related to water pollution.

In the case of aluminium cans, aluminium has a certain market value, and this is often sufficiently high to promote the collection and recycling of aluminium. However, there will be additional benefits to justify such a scheme, in terms of both reduced waste disposal and the reduced extraction of virgin materials. The costs of the aluminium-recycling scheme can be matched against the total benefits, always taking into account the uncertainties, as could any other scheme designed to recycle materials.

In the case of the circular economy, companies with residual waste streams may often be some distance from the market where they obtain the value of materials. As such, the waste products do not relate to their main area of activity and the companies may be forced to dump them at unfavourable prices to nearby plants that are willing to accept them. However, if the authorities institute a set of taxes on the key pollutants, any activity that will diminish the net environmental burden will become profitable for both the receiving and the disposing companies. Alternatively, the authorities may require a socio-economic analysis of the benefits of recycling, as outlined above.

VII. Conclusions

Significant advances in the pricing of externalities have been achieved in recent years by means of complex interdisciplinary analyses that attempt to account in detail for the environmental consequences. The mon- etary estimates reached as a result of such interdisci- plinary research are gradually being applied by the authorities to the economic analysis of environmental policy priorities. A prominent example was the assessment that emerged from the EU's 6th Environ- mental Action Programme (RIVM 2001). This assess- ment relied on the results of the ExternE project, and the economic analysis was based on the use of the National Institute for Public Health and the Environ- ment of the Netherlands' (RIVM) expertise and models for the natural scientific basis.

The challenge in accounting for external effects is very much related to the necessity to transcend disci-plinary orientations and to combine the knowledge and data available in various subfields. That environmental issues are complex has been acknowledged for dec-

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ades, and the resulting predominance of symbolic politics been deplored by many observers. Whether the insights obtained by combining natural science models with economic principles of accounting for external effects will lead to an environmental policy that is more rational and less sensitive to abuse by vested interests is perhaps to early to say, but we can at least hope that a more confined playing field for the clash of interests can be defined.

The establishment of a future trajectory for a circular economy will require that this approach be extended so that the broader issue of sustainability can be addressed more comprehensively. Whereas external effects relate mainly to the present generations, the sustainability issue implies a need to address the future generations as well when the implications of the envi- ornamental pressures are quantified. Although the available estimates for external effects provide only a partial and incomplete picture of the environmental costs at stake, they help support and expand on the analysis of the virtues of a more circular economy.

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Gender Differences in Access to Rural Transport Infrastructure and Agricultural Production: The Case of Horro Guduru Wollega Zone, Western Ethiopia

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Keywords: *gender differences; rural transport; agricultural production; horro guduru wollega.*

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Gender Differences in Access to Rural Transport Infrastructure and Agricultural Production: The Case of Horro Guduru Wollega Zone, Western Ethiopia

Sileshi Tamene [α] & Tebarek Lika Megento [σ]

Abstract- In a society where women's inequality remains deeply rooted gender norms and unequal gender power relations dictate the role of men and women. In Ethiopia, women's access to rural transport is limited. This qualitative research aimed to explore the gender differences in access to rural transport and its implication for agricultural performance. Focus group discussions, in-depth interviews and observations were used to collect data. By using purposive and snowball sampling, a total of 14 in-depth interview, 12 key informant interview and 96 focus group discussion participants were selected. The qualitative data was collected using semi-structured and open-ended interview protocols and analyzed using qualitative thematic content analysis. According to the results of women's focus groups, men control household's transport means (donkey, horse, and mule). Women typically only control such resources if they are female headed household. These activities are done through head-loading or back-loading. To improve rural women's access to transport infrastructures and hence their agricultural productivity, greater consideration needs to be given to interventions in intermediate means of transport, and other time- and load-reducing measures such energy saving cooking equipments and rural child care centers.

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I. Introduction

Around the world, in much of development work, transport above everything is the ultimate enabler since it unlocks growth potentials, creates jobs, and brings wealth to local communities. World Bank (2008) showed that 1 billion poor people in developing countries today lack access to basic all-weather roads. Transport in the rural areas relates principally to basic needs and is carried out mostly on foot or with the aid of intermediate means of transport (World Bank, 2010; Tamene and Megento, 2017). Rural transport-related issues such as access to markets, health care, fuel wood, water, grinding mill and other basic facilities play an important, but underappreciated role in perpetuating women's disadvantaged position in society. Women smallholder farmers living in remote areas have to spend longer hours collecting water or processing food than women living in areas better endowed with infrastructure and this appears to be a significant constraint on their meaningful participation in productive economic sectors like agriculture (FAO, 2010; Gebre-Selassie and Bekele, 2010; porter, 2008).

According to United Kingdom Department for International Development (2010), total agricultural outputs in Africa could increase by up to 20% if women's access to agricultural inputs was equal to men's. Gender gaps in access to rural transport infrastructure seem substantial in sub-Saharan Africa where agriculture is a more important source of livelihoods than in other regions. Reducing this gender gap is therefore, a priority for improving women's access to basic resources in agriculture-based countries (FAO, 2010). Such gender-differentiated access to rural transport infrastructure determines the ability of men and women smallholder agricultural producers to receive fair prices for heir produce.

Women and men occupy different positions and face different working conditions in rural labor markets across the developing world and hence they experience different levels of access to rural transport infrastructure (FAO, 2010; FAO, 2016). Rural men and women have no equal access to rural transport infrastructure and services necessary to achieve their individual potential and fulfill their obligations to the household. Owing to gender biased socio-cultural norms and unequal gender power relations, women in most developing countries have less access to rural transport infrastructure as compared to their male counterparts and hence their ability to own and acquire appropriate time saving transport facilities is restricted (porter, 2008; FAO, 2016). This further differentially determines how they may contribute to and benefit from rural livelihood.

Gender intensified inequalities in access to rural transport infrastructure are complex and require an understanding of how household dynamics and gender power relations interact. The reasons for gender differences in access to rural transport infrastructure are many, and are often intertwined.

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Although different countries have very different levels and trajectories of gender inequalities, in most societies men and women have distinct economic and social roles and responsibilities, and consequently transport use and provision are highly gendered (Bamberger and Davis, 2001; Booth et al., 2000).

Even though, women are not the only vulnerable groups to be susceptible to lack of rural transport infrastructure, due to their specific reproductive roles and responsibilities, they have several unique rural transport needs that were not shared by the majority of their male counterparts (Porter, 2008). The successful transport service and infrastructure developments in rural areas of developing countries are unattainable without due consideration of gender idiosyncratic transport demand and supply patterns (Zogo and Epo, 2016).

Due to their higher decision making power over household resources, men can afford to pay for higher transport costs that rural transporters are able to charge. But, due to their lower incomes and weak bargaining power, women cannot affordable to pay such higher prices for vastly poor transport facilities, which add to the costs of inaccessibility from which they already suffer. Therefore, women are recognized to lack access to rural transport and suffer more acute accessibility problems than their men counterparts. Indeed, the success of harmonious and all-inclusive rural development depends on access to well planned, efficient, affordable and equitable rural transportation systems (Gutierrez and Kuiper, 2010; Holste, 2009).

Even though, not sufficiently recognized and valued, promoting gender equality in access to rural transport infrastructure is an essential component of sustainable economic growth and poverty reduction. Improving women's access to rural transport infrastructure can enhance women's agricultural productivity, economic decision-making power and their entrepreneurial opportunities. Addressing gender equality in access to rural transport infrastructure is therefore central to achieving rural agricultural development goals (Fernando and Porter, 2002).

II. Statement of the Problem

Women are taking up a larger share of agricultural production in many low income countries. At the same time, they continue to be the main care providers for their family members (Grassi et al., 2015). In his speech on the annual meeting of the Clinton Global Initiative during September 2009, the former President Bill Clinton addressed that "Women perform 66% of the world's work, and produce 50% of the food, yet earn only 10% of the income and own 1% of the property" (as cited in OECD, 2011, p. 6). If women had the same access to productive resources as men, they could increase yields on their farms by 20-30%. This could raise total agricultural output in developing countries by 2.5-4%, which could in turn reduce the number of hungry people in the world by 12-17% (OECD, 2011).

Although progress has been made, there are clearly many gender-specific rural transport constraints still at work among smallholder farmers of developing countries. Even in the absence of adequate rural transport provision, women shoulder the main responsibility for household chores, care provision and other unpaid work to support their families and communities (FAO, 2010). Despite women's role and responsibility for a disproportionate share of the household's transport burden, they have more limited access to transport facilities. Unequal gender power relations and the resulting women's weak bargaining power relative to their men counterparts within households severely limit women's ability to make claims over their contributions (FAO, 2010). Marginalization of women in the use of transport infrastructure poses some challenges on maintaining adequate levels of agricultural productivity and is against the principles of gender inclusive rural development (Creighton and Yieke, 2006; FAO, 2011).

A disproportionate share of the unpaid work burden falls on rural women's shoulders, thus restricting the time they have available for productive work like agriculture. The burden of water and fuel collection is likely to reduce the amount of time women can spend in paid work (Grassi et al., 2015; Chen, 2008). Many women smallholder farmers in low-income countries face disproportionate obstacles in accessing and using rural transport as opposed to their men counterparts. These results in women's relative lack of mobility, self-esteem and confidence in relation to men in decision making over household income (Quisumbing and Pandolfelli, 2009; African Development Fund, 2001).

In Ethiopia, where gender biased cultural norms appear to be significant, women have vastly inferior access to rural transport facilities and are less likely to control over how transport resources are mobilized within households. Limited rural transport infrastructure is a challenge mainly in rural areas of Ethiopia with a high dispersion of people and remote villages. Countries with large rural areas such as Ethiopia also display high shares of women having difficult access to motorized, non-motorized as well as local mode of transportation (Dercon et al., 2009; Muleta & Deressa, 2014). Such problems of gender-differentiated access to transportation are partly exacerbated by gender-blind rural transport policies and programs. Women's limited access to rural transport facilities also constrains their access to other important productive resources and opportunities such as extension, microcredit schemes, women-friendly formal financial systems, training, input and output markets, and other complementary supporting services (Ogato et al., 2009). Unequal

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access to such important productive assets is an important source of gender disadvantage likely to undermine the achievement of women's agricultural productivity (Eneyew and Mengistu, 2013; Bryceson and Howe, 1993; Gebre-Selassie and Bekele, 2010).

Gendered transport is a subject that received scant attention from policy makers and development specialists. Despite its necessity in development endeavors, gender equality in access to rural transport infrastructure is not sufficiently recognized and valued. Until now, however, little attempt has been made to assess the extent to which, and how, gender-differentiated impact of rural transport infrastructure constrains rural women's agricultural productivity.

In Ethiopia, by overlooking the vast majority of women who reside in male-headed households, many gender-focused transport and agricultural development researches targeted exclusively women headed households (Muleta and Deressa, 2014; Eneyew and Mengistu, 2013; Ahmed, 2013; Bryceson and Howe, 1993; Dea, 2016). Hence, little attempt has been made to assess the domestic transport burden of women who reside in male-headed households.

In Ethiopia, past transportation studies were more inclined towards urban areas compared with existing work done on the transport situation of women in rural areas (eg., Dagnachew, 2011; Eshete, 2015; Schmidt and Mekamu, 2009; Nyarirangwe, 2008). Limited rural transport studies have been undertaken in Ethiopia focusing more on the effects of rural access roads on poverty and livelihood strategies (Ahmed, 2013; Dercon et al., 2009; Porter, 2012). Consequently, less attention has been devoted to study transport patterns and needs of rural women smallholder farmers. Therefore, rural women's and men's substantially different patterns of mobility constitute a promising area for potential research.

In light of the above research gaps, it becomes expedient to examine the problem of gender differential access to rural transportation infrastructure, so that the extent of the problems can be known, and possible policy interventions delivered to achieving gender inclusive rural development.

III. Objective

The principal objective of the study is to investigate gender differences in access to rural transport infrastructure and its effect on woman's participation in agricultural production.

To achieve the main objective, the following specific objectives are identified:

1. To identify the extent of gender differences in access to and control over rural transport resources and its associated effect on their participation in agricultural production.
2. To examine gender disparities in rural transport mode choice and describe the role of IMT in reducing rural women's transport burden.
3. To investigate gender differences in relation to rural travel pattern and behavior.
4. To explore the major distinction between rural transport burden falling on women and men.
5. To examine the trip chaining characteristics of men and women smallholder farmers.

IV. Research Questions

- Is there gender discrimination in the ownership of and access to rural transport facilities?
- To what extent do gender differences determine rural transport modal choice?
- Are there economic, social and cultural factors in place which determine rural women's /men's travel pattern and transport burden?
- Why women smallholder farmers often trip-chain than their men counterparts?

V. Research Methodology

This methodology section gives a brief account of the study area, research design, data collection strategies and data analysis. It also provides a detailed account of ethical issues related to data collection and challenges faced the research process. Since there was no one right technique to collect qualitative data, a combination of data collection methods including focus group discussions (FGDs), in-depth interviews (IDIs), key informant interviews (KIIs), and participant observation were used to offer a holistic interpretation of the phenomenon being studied. Interviews and focus group discussions were tape-recorded, transcribed verbatim and analyzed using inductive thematic analysis approach.

VI. Study Area

This study was conducted in Horro Guduru Wollega zone, Western Ethiopia. The capital town of the zone, Shambo, is located 314 km away from Addis Ababa to the Western part of Ethiopia. The zone comprises nine rural districts. According to the report of (CSA 2011), Horro Guduru Wollega zone covers a total land area of 8,097km^2; a total population of 641,575 of which 50.09% are male and 49.91% are female. This study was conducted in four districts of Horo Guduru Wollega zone namely, Ababo Guduru, Horro, Abe Dongoro and Amuru (Figure 1).

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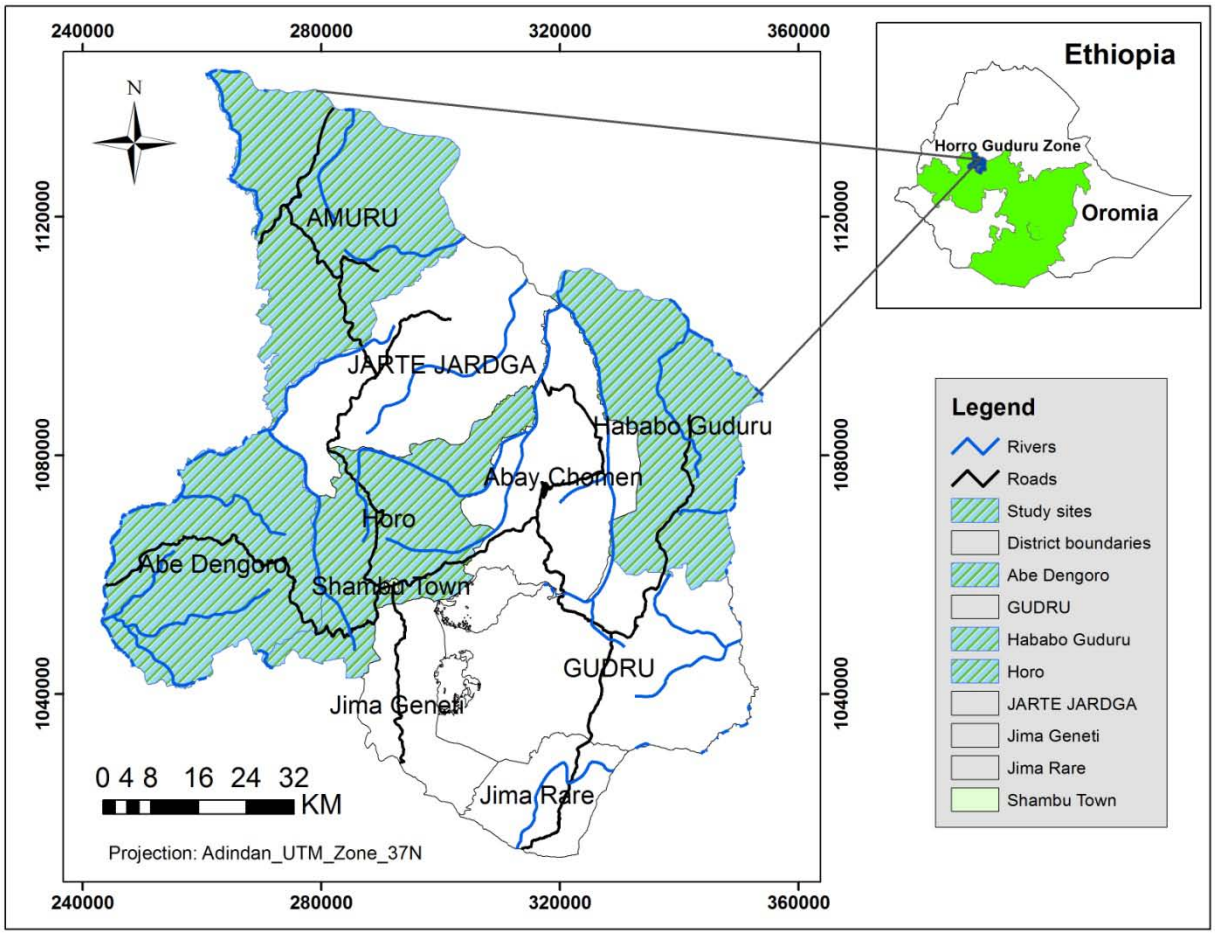

Source: Adapted Finance and Economic Development Bureau of Oromia, 2016

Figure 1: Map of study area, Horro Guduru Wollega Zone by districts

VII. Research Design

In light of the research design, this research employed exploratory qualitative research design. Since the aim was to explore an in-depth description of real-life experiences of gender differences in access to rural transport infrastructure and agricultural production, qualitative approach was chosen for this specific research (Creswell, 2012). Qualitative research methods are also effective in identifying intangible factors, such as social norms, socio-economic status, gender roles and gendered differences and characteristics in a society (Denzin & Lincoln, 2005). Qualitative research methods are often employed to obtain more detailed descriptions and explanations of experiences, behaviors, and beliefs. Furthermore, it can answer the whys and hows of human behavior, opinion, and experience—information that is difficult to obtain through more quantitatively-oriented methods of data collection. The philosophical views of the study were focusing more on the constructivist view that deals with gender differences in access to household resources. The methodology used was Interpretive Description. Both primary and secondary data sources were used for this study. The primary sources were obtained via key informant interview (semi-structured), in-depth interview (unstructured), observation tools and focus group discussions.

The research used interpretivism epistemological viewpoint, since the aim of this research is more interested in interpreting deeper meaning in discourse that is represented in a collection of personal narratives or observed behaviors and activities. Since this research is concerned with revealing multiple realities as opposed to searching for one objective reality, interpretivism epistemological viewpoint was taken for granted as appropriate philosophical framework.

VIII. Study Population and Sampling

Purposive and snowball sampling were used to recruit participants for FGDs, IDIs and KIIs. First, 12 focus group discussions (4 with women smallholder farmers, 4 with men smallholder farmers and 4 with mixed sex smallholder farmers) were held in 16 rural kebeles across four districts of Horro Guduru Wollega Zone (Ababo Guduru, Abe Dongoro, Amuru, and Horro).

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In each focus group discussion an average of 8 individuals were participated. Therefore, a total of 48 women and 48 men smallholder farmers were participated in focus group discussions. Second, from each rural kebeles of the study districts one men and one women smallholder farmer (i.e. 16 men and 16 women) were purposively selected to participate in in-depth interviews. Therefore, a total of 32 IDIs were conducted in 16 different rural kebeles across the four study districts. Finally, expert purposive sampling was used to select the 2 male and one female local government officials from each of the four study districts making up a total of 12 key informants for the study (table 1). The key informants consisted of one expert each from district agricultural office, district rural transport office and district gender office.

Table 1: Distribution of in-depth interviews, key informant interviews and focus group discussions

Districts	IDIs (32)		KIIs(12)		FGDs(96)		
	women	men	women	men	women	men	mixed sex
AbaboGuduru	4	4	1	2	8	8	4 each sex = 8
Abe Dongoro	4	4	1	2	8	8	4 each sex = 8
Amuru	4	4	1	2	8	8	4 each sex = 8
Horro	4	4	1	2	8	8	4 each sex = 8
Grand Total	16	16	4	8	32	32	16 each sex = 32

Sources: own design, 2016

IX. Data Collection Methods and Tools

a) Focus Group Discussions

A focus group discussion (FGD) is a form of interview that involves addressing questions to a group of individuals who have been selected for this specific purpose. This approach offers the opportunity of allowing people to probe each other's reasons for holding a certain view. In this study, 12 FGDs were conducted to obtain the experiences of men, women and mixed sex smallholder farmers towards the topic under study. In total, there were 32 women, 32 men and 32 mixed sex participants.

To solicit more information than what could be obtained from individual farmers, FGDs were held with women, men and mixed sex farmers' groups in different rural kebeles of the study districts. Focus group discussion was designed to solicit information from participants not only on their own perception but on the community perceptions, thoughts, feelings, experiences, reactions and attitudes towards gender differences in access to rural transport infrastructure and its implication for agricultural production (Kvale, 1996)

While recruiting the focus group discussion participants, special emphasis was placed on the composition of the group participants in line with Robinson (1999). Both single-sex and mixed groups were included in the study, as well as the age and religion of focus group members was also considered. Equal numbers of women and men smallholder farmers were included in the FGDs in order to give different chances of representation of views. During each focus group discussion maximum care was also taken to minimize dominant voices that can skew results and affect participation of others. A moderator or group facilitator is usually engaged to guide participants and help them participate in the discussion. Female facilitators were used in women focus group discussions to avoid the potential barriers and encourage them to speak up and express their ideas freely. Experienced local facilitators/moderators were used to encourage participation, build trust and relationships and support an open discussion among focus group discussants.

By taking a great care of restraining themselves from sharing their views about the topic of discussion, facilitators or moderators played a great role in time management, in interviewing and guiding the group's discussions. They also established a comfortable atmosphere within the group encouraging all participants to be part the discussion.

The main topics of the discussion were gender roles and relations, men's and women's to access and control over rural transport infrastructure, day-to-day mobility patterns of men and women, travel purposes of men and women smallholder farmers and existing practices and challenges in rural transport infrastructure. Using the observation method alongside FGDs helped the researcher to capture individual emotions as well as non-verbal information (facial expressions, changes in volume of speech and body language) from FGD participants. The FGDs were conducted using interview guides as data collection tools aiming at answering the already set objectives. These interview FGD guides were developed before the study and improved upon after the pilot study. The guides were designed in such a way that many possible answers could be derived from the discussion, while avoiding short questions and leading questions.

b) In-depth Interviews (IDIs)

In-depth interviews are useful in collecting more in-depth information or exploring new issues in-depth on sensitive topics that are less likely to be discussed in groups (Boyce and Neale, 2006). In-depth interviews

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were used to enable the researcher to explore in detail each smallholder farmer's perspective on gender differences in access to rural transport infrastructure. Hence, in four districts of Horro Guduru Wollega zone a total of 32 in-depth one-on-one interviews (8 in-depth interviews in each district) were conducted. These face to-face in-depth interviews were carried out with one male and one female smallholder farmers in each rural kebeles of the four study districts making up a total of 8 and 32 in-depth interviews in each district and across four districts of the study area respectively (Table 1). IDI participants ranged in age from 30 years to 65 years, with an average of 45 years of age. Just like in FGDs, an equal number of men and women smallholder farmers were participated in in-depth interviews.

The participants in the in-depth interviews were purposively selected from the focus group discussants based on their knowledge of the issues of investigation. Each IDI took approximately 30 to 40 minutes and carried out by the researcher together with one trained facilitator between January and February 2016. Most in-depth interviews were held in neutral venues which provided reasonable privacy for the participants.

The central questions of the in-depth interviews focus on women's rural travel needs and choices, intra-household decision-making on the use and control over household resources including rural transport facilities and the availability of IMT. Women's disproportionate rural transport load and their agricultural productivity, respondent's personal attitude towards the division of productive and reproductive work among male and female family members as well as social and cultural norms hindering rural women's access to rural transport infrastructures were also among the main topics addressed during in-depth interviews.

To obtain detailed information from in-depth interview participants, an unstructured interview guide was used. This interview guide was pre-tested with two smallholder farmers (one male and one female) and amended based on this pilot test. All of the in-depth interviews were conducted in Afan Oromo, translated in to English and then transcribed. Of the total 32 IDIs 23 of them were tape recorded, for the nine unrecorded interviews, the researcher took notes and wrote up the detailed accounts after each interview session is completed.

c) Key Informant Interview (KII)

Key informant interviews provide more vertical depth to the information already gathered through participant observations and focus group discussions. It also helps to obtain expert opinions and perceptions on appropriateness, effectiveness, and sustainability of programs and strategies directly related to the topic under study. Key informant interviews were mainly aimed at gaining appropriate contextual information and to clarify some issues that appeared vague or uncertain from the information gained through the focus group discussions (Bernard, 2006).

Key informant interviews were used to collect information from people with specific knowledge and experience of rural transport infrastructure and agricultural production. The aim was to obtain information that would not easily be obtained from focus group discussions and IDIs. Hence, for this specific study three key informant interviews were conducted in each district making up a total of 12 KIIs (Table 1). The interviewees were a District Agriculture Officer, a District road transport Officer and a District Gender Officer.

One one-on-one semi-structured interview with district level women gender officer who work on gender equality and empowerment were conducted in all study districts. KIIs were conducted towards the end of the field work (during April 2016) after FGDs and IDI were completed. For the purpose of these interviews, interview guide was made available aiming at answering the already set research objectives.

Key informant interviews were conducted with local government officials who were professional expertise and knowledgeable in matters related to gender differences in access to rural transport infrastructure and agricultural production. Key informants were purposively selected from different sector offices (agriculture and rural development, rural transport and gender office) on the basis of relevance, functions and involvement in transport, agriculture and gender issues. Key informants were interviewed at their places of work.

X. Method of Data Analysis

Qualitative inductive thematic data analysis was used to manage and analyze data collected from FGDs, IDI and KIIs. After collecting the primary qualitative data from the study participants, all information is coded according to specific individual code number. Focus group discussions, in-depth and key informant interviews were tape-recorded, transcribed verbatim and analyzed using inductive thematic analysis method. A Field note was organized into easy to retrieve sections to help the researcher to familiarize himself with the data. The researcher read through the interview responses to look for and uncover themes, trends and patterns, which were used to code the findings. Coding then began for each category of research participants of women and men smallholder farmers, from which themes emerging from the data were generated for analysis. Field notes and Interview transcripts were analyzed using an inductive thematic approach geared towards identifying patterns in the data by means of thematic codes (Bowen, 2005). Thus, the themes of analysis emerged from data coding after the data was collect, rather than before the fieldwork. Data coding and analysis was done manually using Microsoft Excel

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for recording. The themes that emerged from the codes form the basis of findings.

XI. Ethical Issues

Maximum care was taken to ensure the privacy, respect, and dignity of all research participants at all levels. Personal Identities of participants in the FGDs and in-depth interviews remain anonymous. FGD moderators received one-day training in research ethics, including confidentiality. Confidentiality was also emphasized at the beginning of each FGD, in-depth interview and key informant interview and a statement agreeing to maintain confidentiality was included as part of the participant consent forms.

XII. Results and Discussion

a) Gender differences in access to rural transport infrastructure

In rural areas access needs and patterns of travel and transport vary from men to women depending on types of local culture and tradition. Differences between female and male key informant interviewees were noted on their opinions regarding gender differences in access to rural transport infrastructure. Overall, all but one of the female key informant interviewees thought that gender equality in access to rural transport infrastructure is an important development goal as well as something that should be integrated into government policy and program at all levels. The male key informant interviewees, however, had a wider variety of opinions regarding the importance of gender equality in access to rural transport infrastructure, from very supportive to very negative.

In general, two main points of references arise when gender differences in access to rural transport infrastructure are discussed with key informant interviewees. The first and most common view is that gender differences are important in the context of the rural transport sector. This perspective is held by a majority of the women and four of the men. It is based on the reasoning that there are differences between women and men smallholder farmers and their travel needs or modal choices, such differences demand careful rural transport policy and program at all levels. Such experts and practitioners believe that it is more important that all users be ensured equal accessibility regardless of sex and that this aspect is already covered in ensuring that the transport system be accessible to all. The other four of men key informant interviewees doubt the relevance of gender equality in access to rural transport infrastructure.

There is a marked gender gap in access to and control over productive resources. This finding is in line with the study conducted in Uganda by World Bank (2014) that states women comprise a significant share of the work force in agriculture but have unequal access to and control over productive resources including access to rural transport resources. The same study revealed that, due to gender differential access to rural transport infrastructure, women's productivity in agriculture still lags significantly behind men's.

The second perspective held by women and men key informant interviewees is that gender differences in access to rural transport infrastructure is less important in the context of the rural transport infrastructure and agricultural sector. This view is held by half of the men and one of the women. It is based on the premise that even though there are differences in access to rural transport infrastructure between women and men and their travel patterns and demands, such variations lack relevance and therefore have no effect on agricultural productivity of smallholder farmers. These groups of KII participants believe that rural transport policy and planning are gender neutral.

b) Gender and rural transport mode choice

Traditional or local means of transport, including donkeys, horse, mule and animal drawn carts, may have an important role to play in filling the transport gap where conventional motorized transport services are poor. However, women focus group participants in Amuru showed that the ownership and use of traditional or local means of transport is widely male-dominated as a result of economic and/or socio-cultural factors. In other districts of the study site women focus group discussants mentioned several constraints that women face in accessing and using local transport means including women's more limited income to purchase local transport means, their restricted access to such means without the permission of their male counter parts, women's perceived lack of physical strength to handle draught animals or push animal drawn carts, cultural prohibitions on women in riding draught animals like horse and mule (Porter, 2007).

According to personal observations across all study districts, Walking and back loading, shoulder loading or head loading are the major means of travel and transport. Animal drawn carts are available only in very few rural kebeles due to the absence of accessible roads. The available animal drawn carts are mostly used for non-domestic travel and transport activities as opposed to domestic and social activities carried out by women. In its appraisal report about Wacha-Maji road upgrading project, African Development Fund (2002), clearly showed the heavy work load and consequent time constraints of rural women in Ethiopia.

c) Gender similarities and differences in relation to travel pattern and behavior

One of the core gender issues of access to transport services that emerged in the mixed sex focus group session in Ababo Guduru district was gender differential impacts of rural transport infrastructure. These focus group discussants seem to agree that the

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multiple reproductive roles of women tended to dictate their mobility in terms of how far and how long they can travel from the residence. As it is possible to understand from the views of women and men KII participants, while men consistently travel further than women and are more likely to travel by traditional or motorized transport means, the mobility patterns of women in rural areas tend to relate to their domestic, economic and social tasks. Women make trips to take care of their children, fetching water, firewood and food processing, handle household responsibilities and to maintain community and social networks. These major differences in the mobility needs of rural men and women are grounded in the traditional gender-based division of labor. Yet, gender-related norms, practices and perceptions continue to ensure that men's and women's opportunities remain unequal. For rural women the most prominent mode of travel remains walking and head-loading or back-loading. Because rural women are vulnerable members of the society due their multiple productive, reproductive and Community roles, considering how rural transport policies and projects address their needs is important for socially and economically sustainable rural transport policy.

Many researches on gender travel characteristics revealed that a dichotomy exists between men and women mobility patterns in both developed and developing countries particularly with respect to modal choice, distance travel and frequency of trips to different locations (Peter, 2000; Oyesiku, 2002; Adetunji, 2013).

Improved rural access roads required women to exercise more caution in looking after children, fearing that without their constant supervision children would run onto the road. Similarly, one of women in-depth interview participant in the same district commented on significant differences in access, mobility and accessibility between men and women in utilizing both local level transport and motorized transport methods. Studies elsewhere have identified some major gender differences in access to transport where women experience constraints on their mobility due to their reproductive work, cultural restrictions, and different travel needs from their men counterparts (Porter 1995, 20002; Mandel 2004).

Therefore, this study explored the gender differences in access to rural transportation and mobility, responsiveness of rural transport systems to needs and choices of women and their participation in decision making over the use and control of household transport facilities. The results of this qualitative research study show significant disparity in trip rate, duration and purpose of travel, travel behavior, travel mode between women and men in all districts of the study area. Therefore, increasing women's access to rural transport assets and narrowing the gender gap would directly improve women's agricultural productivity by reducing their vulnerability and enhancing their self-esteem, bargaining power and sense of control. This is not only important for women's benefit alone but for the well-being of the household in general.

d) Women's domestic responsibilities and rural transport

This qualitative research study investigated in detail travel patterns in four districts of Horro Guduru Wollega Zone for access to domestic facilities, with a special focus on the transport of water, firewood and of crops to grinding mills. According to FGD results almost all households travel to a grinding mill once in a week. The time and energy involved is directly proportional to the distance to the mill. Establishment of crop grinding mills at village level or closer to the home reduces the transport burden of women related to this activity at the same time would release time and energy for productive and socially beneficial activities. Many women focus group participants emphasized the need to form rural female cooperatives that provide grain milling services for their communities and thus reduced women's heavy burden.

With the exception of 3 women participants in IDI, all others make trips to the grinding mill on foot through either head-loading or back-loading and almost all households are more than one and half hour away from the grinding mill. For those who used local transport means like donkey to carry grain crops to the grinding mill and back home, even though the load was carried on a donkey-the owner still walked. It was the woman who went to grind the grain in almost all cases. In occasions when a woman gives birth for a child or get sick, a man will be forced to go to the grinding mill. But, he tends to use a locally available means of transport or other intermediate means of transport.

A closer look at the view forwarded by both men and women focus group discussion participants reveals that gathering firewood for cooking represents a significant portion of rural women's time and energy. Shackle ton et al. (2011) and Sunderland (2012) also confirmed that firewood collection is a solely female responsibility. Time spent collecting firewood for fuel as well as the cooking and related cleaning activities are a drain on the time of the women primarily responsible for these tasks. Especially as local firewood supplies continue to diminish due to deforestation, rural women have to cover substantial distances on foot to collect firewood from distant sites. In another study (Green stream, 2010) it was reported that women have to cover considerable distances on foot to collect firewood for household use and for sale, as it is one of the few avenues open to them to meet their requirements for a basic income. Lack of rural transport facilities are additional barriers to women in accessing firewood in the form of limited supply. In terms of addressing households' need for firewood, planting fast-growing

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trees close to the village was given greater attention by key informant participants across all study districts. Various fuel saving technologies (fuel-efficient or improved stoves) therefore important in order to reduce the amount of firewood women have to use for cooking and freed-up time for income-generating activities.

e) *Trip chaining characteristics of men and women smallholder farmers*

"I have three reasons for going to market. One, I must buy for household consumption, two, I have to go to grinding mills, three, I have to ask relatives and four, sometimes taking sick family member to health center." [41 years aged women IDI participant, Horro district]. This comment was made as a response to a travel pattern during in-depth interview. Many other women farmers in other districts of the study area made similar comments. Their words draw attention to the fact that women are most likely to form complex trip chains (combine several purposes into one trip) and their multiple responsibilities require them to combine work trips for different purposes. This finding is in line with the findings of (Rosenbloom, 1988; Rosenbloom, 1989; Strathman and Dueker, 1994; McGuckin, and Murakami ,1999; Al-Kazily et al., 1994, which argues that compared to men, women are more likely to trip chain on the way to and from work. Therefore, rural transportation issues for women differ from those for men in that women frequently face circumstances that many men do not. In particular, among women FGD participants (Horro, Amuru, and Abedongoro) the determining factors for transport modal choices are: the necessity of making multiple activities (trip-chaining)-marketing, grinding mills, taking child to clinic for medical follow up. Therefore, this analysis reveals that trip-chaining behavior is related to gender roles and responsibilities.

XIII. Conclusion and Recommendation

Gender is an important but largely neglected aspect of rural transport infrastructure planning and provision. Men and women hold different socio-economic roles and responsibilities that are associated with different patterns of transport access, needs, and use. For many women in rural areas, walking remains the predominant mode of travel, because other transport modes are often not available, are culturally not encouraged, are too expensive, or are located too far away from home for women to access. In Ethiopia, despite women's essential contribution to household food production and provision, their access to rural transport infrastructure is limited. The existing rural transport systems of Ethiopia are not adequately geared towards the needs of women. This research aims to find ways forward in order to alleviate rural women's disproportionate transport burden in rural districts of western Ethiopia.

The problem of gender differential access to rural transport infrastructure is apparent in Horro Guduru Wollega Zone, where women's control and decision making power over household incomes are low and transport services are few. Conventional rural transport planning has overlooked village level transport solutions for short-distance transport, especially the needs of women smallholder farmers. Based on Inductive thematic analysis approach in rural districts of western Ethiopia, this study explores gender differences in access to rural transport infrastructure and its implication for agricultural production.

To improve rural women's mobility and hence their agricultural productivity, greater consideration needs to be given to investment in local footpaths, footbridges, village level roads, intermediate means of transport, and other time- and load-reducing measures. Rural transport infrastructure planning efforts should consider the needs of women smallholder farmers. Intermediate means of transport plays a great role in facilitating local level transport activities. Because women were responsible for most transport around the village, they benefited from the spread of animal drawn carts, hand carts, wheelbarrows which could be used to carry people, water, firewood and crops. Therefore, to improve rural women's access to rural transport infrastructures and hence their agricultural productivity, greater consideration needs to be given to investment in intermediate means of transport, and other time-saving and load-reducing measures such energy saving cooking equipments and rural child care centers.

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Spatial Structure of Mountain Forests of the Lake Baikal Southwestern Coast

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Abstract- Spatial structure of mountain forests of the Baikal region is presented through geobotanical mapping. Correlated analysis of the vegetation cover structure and data of landscape investigations was done. The study area is characterized by a high natural diversity of plant communities with dominating forests reflecting the ecotopes differentiation in mountain conditions as well as by the contact of regional physical geographical structures and experiencing anthropogenic impacts. The map legend conveys the identified spectrum of forests diversity. Area is provided for the integrated stability areas of plant communities. Forest stability is regarded as ability of plant communities to retain their phytocenotic structure. An expert assessment of stability is made. This territory is notable for dominance of stable and moderately stable forest communities. The modern mosaic-dispersed distribution of communities of equifinal successional stages gives evidence of the current favorable conditions for preservation of dark coniferous forests.

Keywords: *forests spatial structure; mapping; landscape structure; forests stability.*

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Spatial Structure of Mountain Forests of the Lake Baikal Southwestern Coast

Eugene G. Suvorov [α] & Natalia I. Novitskaya [σ]

Abstract- Spatial structure of mountain forests of the Baikal region is presented through geobotanical mapping. Correlated analysis of the vegetation cover structure and data of landscape investigations was done. The study area is characterized by a high natural diversity of plant communities with dominating forests reflecting the ecotopes differentiation in mountain conditions as well as by the contact of regional physical geographical structures and experiencing anthropogenic impacts. The map legend conveys the identified spectrum of forests diversity. Area is provided for the integrated stability areas of plant communities. Forest stability is regarded as ability of plant communities to retain their phytocenotic structure. An expert assessment of stability is made. This territory is notable for dominance of stable and moderately stable forest communities. The modern mosaic-dispersed distribution of communities of equifinal successional stages gives evidence of the current favorable conditions for preservation of dark coniferous forests.

Anthropogenic impacts are concentrated in the coast of the Lake Baikal dominated by areas of forest communities of stably long-lasting and short-lasting derivative stages of successional recovery. The lower mountain-taiga belt and adjacent submontane plains with tracts of Baikal's terraces are dominated by structures of weakly stable and unstable areas. Geosystem differentiation gives conditions for the occurrence of different forest communities as well as the spatial inhomogeneity of the stability areas in relation to primary and derivative structures in light of the existing kinds and intensity of anthropogenic impact.

Keywords: forests spatial structure; mapping; landscape structure; forests stability.

I. Introduction

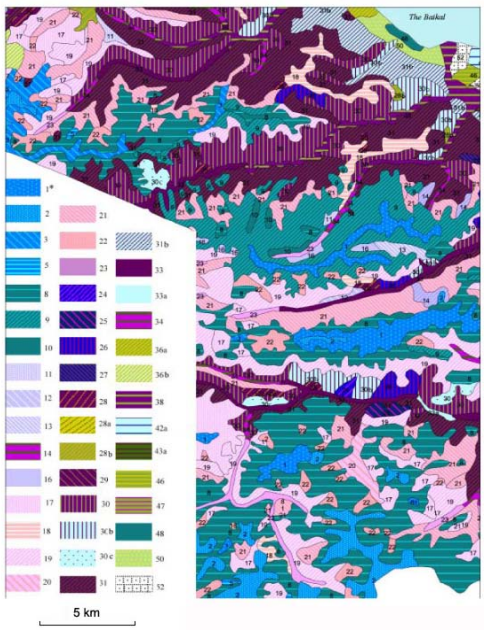
Studies of structural dynamic features, spatial organization of geosystems and environmental forming and environmental retention role of vegetation in the territory next to the Lake Baikal are conducted for the purpose of nature management policy developing of the Baikal natural territory, priority of which are the actions, directed toward the maintenance of geosystems in the natural state of functioning, providing conditions for unique natural water resource forming. The complicated geological engineering conditions of this area require the realization of approaches of rational mountain nature management in such place.

The study of the natural conditions differentiation and their determining processes in the south of Baikal is conducted according to the thematic directions, which cover different nature components, and also by complex physical geography, which investigates variety, regional specific character and dynamics of natural complexes or geosystems. One of the fundamental directions of such studies–spatial presentation of territory differentiation, based on the mapping results.

In this article on the basis of the expert evaluation of the sustainability of plant communities and mapping of the contemporary geosystem states the attempt to assess bearings of their territorial stability was made. Case study is executed basing on the example of the territory of the south Baikal.

II. Methodical Approaches

Regularities of forests communities distribution within the case study area are reflected on that carried out map by the authors of the contemporary state of the vegetation of the Slyudyanka region in 1:400 000 scale, that represent the existing variety and the state of plant communities taking into account their primary and derived structures (Novitskaya and Suvorov 2012). Map material for this paper was worked out with ArcView 3.2a programme. We gave the fragment of the investigated section (Fig. 1).



* *Taxon numbers are in Legend*

Fig.1: Fragment of the map "Contemporary state of the vegetation of the southwestern Baikal region"

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For mapping we used the materials of ours field research routes for the different years with complex physical geographical descriptions, the results of aero- and space photograph deciphering, and extrapolating data of large-scale mapping of several key plots, materials of reginal forest survey, and also the analysis of the existing literary sources, too (Epova 1960a, 1960b; Medvedev 1986; Molozhnikov 1986).

Representation of ecotopic structure for this map was based on the differentiation of the topographical structure and the assessment of the contemporary dynamic state of geosystems and it was connected with the carrying out the maps of the physical geographical chorological and landscape typological differentiation of geosystem structure in the south of Baikal (Suvorov and Titaev 1999; Suvorov 2002, 2012) according to properties of the facies (large scale geosystem unit) structure of this territory and taking into account its generalization with mapping on different scales.

As a whole the legend of geobotanical map transfers the variety of the region forest communities and reflects the genetic structure and dynamic principles of typification and construction of the plant communities classification (Sochava 1979). The characteristic of the primary lands of taxons contains fundamental fitosociology characteristic and information on conditions of locality, their dynamic states (the latter were designated by literal indices).

Legend to the map

"Contemporary state of the vegetation of the southwestern Baikal region"

Vegetation
High mountain vegetation
Mountain tundras

The South- Siberian formations

1. Unclosed groups (*Saussurea pricei* (Konspekt…2005), *Tephroseris turczaninovii*, *Smelowskia bifurkata*) of the nival denudation and alpine type relief forms.
2. Mosses (*Aulacomnium turgidum*, *Dicranum elongatum*)-lichen (*Cetraria cuculata*) tundras with sections of dryad (*Dryas oxyodonta*) and meadow tundras of the flattened surfaces and gently slopes.
3. Bergenia (*Bergenia crassifolia*)-bilberry (*Vaccinium myrtillus*)-phyllodoce (*Phyllodoce caerulea*) with *Rhododendron adamsii* lichen of summit moor lands and of gently slopes.
4. Willow (*Salix glauca*, *S. sajanensis*)-ernik (*Betula rotundifolia*) communities of flattened surfaces.
5. Ernik (*Betula rotundifolia*)-willow (*Salix saxatilis*) communities in combination with subalpine meadows of gently slopes and catchment lows.
6. Sedge (*Carex bigelowii subsp. ensifolia*) and cotton-grass (*Eriophorum sp.*) communities of the swampy lows.

Alpinotype meadows

The South- Siberian formations

7. Alpinotype *(Aquilegia glandulosa, Trollius sajanensis)* and subalpinotype *(Geranium albiflorum, Saussurea latifolia)* meadows, brushwood thickets *(Betula rotundifolia, Salix glauca, Duschekia fruticosa).*

Taiga (boreal) vegetation
Subgoletz sparse woods and brushwood thickets
Bering phratry of formations
Baikal -Dzhugdzhur formations
Mountain pine thickets (Pinus pumila)

8. Mountain pine with *Rhododendron aureum* lichen-mosses communities of the flattened surfaces and slopes.
9. Mountain pine with *Vaccinium vitis-idaea* communities of steep slopes.
10. Mountain pine with *Rhododendron aureum* true mosses communities with sections of the subalpine meadows of trough valleys.

Ural-Siberian phratry of formations
South-Siberian formations

Dark coniferous sparse woods
Firry forests (Abies sibirica)

11. Firry subshrub (*Vaccinium myrtillus*, *Empetrum nigrum*, *Vaccinium vitis-idaea*, *Rhododendron adamsii*)-lichen-true mosses with sections of subalpine meadows sparse woods of watersheds and slopes.
12. Firry subshrub (*Vaccinium myrtillus*, *Vaccinium vitis-idaea*)-true mosses sparse woods in combination with grassy, subshrub-forb fir mountain parks and with multiple-forb meadows of flattened surfaces and southern gently slopes.
13. Firry bergenia-cowberry (*Vaccinium vitis-idaea*)-forb sparse woods of steep southern slopes.
14. Firry with with a touch of spruce and Siberian Stone pine with mountain pine subshrub (*Ledum palustre*, *Vaccinium vitis idaea*)-bergenia-true mosses sparse woods of steep northern slopes.
15. Firry and spruce-fir with Siberian Stone pine and mountain pine and with *Rhododendron aureum* subshrub (*Ledum palustre*, *Vaccinium myrtillus*, *Vaccinium vitis-idaea*)-true mosses sparse woods of northern gently slopes.
16. Firry subshrub (*Ledum palustre*, *Vaccinium vitis-idaea*)-grass with the sections of tall grass meadows sparse woods of trough valleys.

Siberian stone pine forests (*Pinus sibirica*)

17. Siberian stone pine ernik (*Betula rotundifolia*)-subshrub (*Ledum palustre*, *Vaccinium vitis-idaea*)-true mosses sparse woods of watersheds and slopes.
18. Siberian stone pine and fir-Siberian stone pine rhododendron (*Rhododendron aureum*)- subshrub

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(*Vaccinium myrtillus*, *Empetrum nigrum*, *Vaccinium of vitiы idaea*)-short grass-true mosses sparse woods of flattened surfaces and southern gently slopes.

19. Siberian stone pine and fir-Siberian stone pine subshrub-forb with bergenia true mosses sparse woods of southern steep slopes.
20. Siberian stone pine and fir-Siberian stone pine with larch and with mountain stone pine and *Rhododendron aureum* subshrub-true mosses sparse woods of northern gentle slopes.
21. Siberian stone pine and fir-Siberian Stone pine with larch with mountain pine subshrub (*Ledum palustre*, *Vaccinium vitis idaea*)-bergenia-true mosses sparse woods of northern steep slopes.
22. Siberian stone pine with mountain pine and *Rhododendron aureum* subshrub grassy sparse woods of trough valleys.
23. Siberian stone pine-spruce and spruce-Siberian stone pine with fir and larch with the spots of mountain pine shrub (*Ribes glabellum*, *Spiraea salicifolia*, *Lonicera pallasii*) grass-mosses sparse woods of mountain valley.

Mountain taiga forests

Firry forests (*Abies sibirica*)

24. Firry and spruce-fir cowberry-true mosses, bilberry-true mosses (*Pleurozium schreberi*, *Hylocomium splendens*) short grass (*Trientalis europaea*, *Maianthemum bifolium*)-large grass-small reed-forb forests of watersheds and gently sloping southern slopes.
25. Firry and fir-spruce with Siberian stone pine marsh tea (*Ledum palustre*)-subshrub short grass (*Trientalis europaea*, *Maianthemum bifolium*)-true mosses (*Pleurozium schreberi*, *Hylocomium splendens*), cowberry (*Vaccinium of vitis-idaea*)-true mosses with bog mosses (*Sphagnum sp.*) of gently sloping northern slopes.
    25a. Birch and aspen subshrub-grass derived communities.
26. Firry and Siberian stone pine-firry subshrub-true mosses with bergenia and cowberry-forb with bracken forests of steep southern slopes.
    26a. Pine-larch cowberry-grass derived communities.
    26b. Birch and aspen small reed-grass derived communities.
27. Siberian stone pine-fir with dushekiya (*Duschekia fruticosa*) subshrub (*Ledum palustre*, *Vaccinium myrtillus*, *V. vitis-idaea*) bergenia true mosses, cowberry-short grass (*Trientalis europaea*, *Maianthemum bifolium*, *Mitella nuda*)-true mosses forests of steep northern slopes.
    27a. Birch dushekia subshrub grassy with bergenia derived communities.

Siberian stone pine forests (*Pinus sibirica*)

28. Siberian stone pine, by places *Rhododendron aureum*, subshrub (*Vaccinium myrtillus*, *V. vitis-idaea*) short grass (*Trientalis europaea*, *Maianthemum bifolium*) polytric (*Politrichum commune*)-true mosses (*Pleurozium schreberi*, *Hylocomium splendens*) forests of watersheds and gently sloping southern slopes.
    28a. Larch-pine subshrub short grass-true mosses, pine-larch cowberry true mosses derived communities.
    28b. Pine-larch short grassy true mosses, forb-small reed derived communities.
    28c. Birch and aspen grassy derived communities.
29. Siberian stone pine with larch marsh tea-subshrub (*Vaccinium myrtillus*, *V. vitis-idaea*)-short grass(*Trientalis europaea*, *Maianthemum bifolium*, *Mitella of nuda*)- polytric-true mosses (*Pleurozium schreberi*, *Hylocomium splendens*) forests; great bilberry (*Vaccinium uliginosum*)-marsh tea true mosses with *Sphagnum sp*. forests of gently sloping northern slopes.
    29a. Larch with the pine cowberry short grassy true mosses; larch marsh tea sedge-bog mosses derived communities.
    29b. Aspen-birch with larch and pine cowberry forb-short grass-small reed, marsh tea sedge bog mosses derived communities.
30. Siberian stone pine cowberry with bergenia forests of the steep eroded southern slopes.
    30a. Larch with pine cowberry forb derived communities.
    30b. Birch marsh tea-forb derived communities.
    30c. Shrub-grass derived communities.
31. Siberian stone pine with larch dushekia (*Dusshekia fruticosa*) subshrub-marsh tea short grass (*Trientalis europaea*, *Maianthemum bifolium*, *Mitella of nuda*)-true mosses (*Pleurozium schreberi*, *Hylocomium splendens*) with bergenia forests of steep northern slopes.
    31a. Larch with pine dushekia cowberry-true mosses derived communities.
    31b. Birch dushekia short grass-moist grass with fern cowberry-short grass-true mosses; sedge-short grass derived communities.
32. Siberian stone pine with larch cowberry true mosses forests (*Pleurozium schreberi*, *Hylocomium splendens*); Siberian stone pine with larch cowberry short grass-true mosses forests; marsh tea short grass-true mosses forests of gently sloping northern slopes.
    32a. Larch and Siberian stone pine-larch with birch cowberry-forb and ccowberry-true mosses derived communities.

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32b. Birch and aspen cowberry-forb and cowberry-true mosses derived communities.

33. Spruce-Siberian stone pine with fir, larch, fragrant poplar (*Populus suaveolens*) dushekia- willow small reed (*Calamagrostis langsdorffii*)-large grass forests of valleys.
    33a. Birch with larch, Siberian stone pine, fir, fragrant poplar large grass-small reed derived communities.
    Spruce forests (*Picea obovata*)
34. Larch-spruce with Siberian stone pine forb-horse tail-small reed (*Calamagrostis langsdorffii*) brush-covered forests of mountain valleys.
35. Siberian stone pine-spruce with larch dushekia bushy forb-gramineous forests of well drained gully bottoms.
    35a. Birch dushekia forb-gramineous derived communities.
    Larch forests (*Larix sibirica*)
36. Siberian stone pine-spruce-larch forests of steep northern slopes with the presence of mountain pine in undergrowth.
    36a. Larch with Siberian stone pine and spruce with the presence of mountain pine derived communities.
    36b. Birch with Siberian stone pine and spruce with the presence of mountain pine derived communities.
37. Siberian stone pine-spruce-larch small birch (*Betula humilis*)-bushy (*Salix sp., Ribes glabellum*, *Spiraea salicifolia*, *Lonicera pallasii*) great bilberry-marsh tea sedge-bog mosses forests of wide swampy valley bottoms .
38. Larch with Siberian stone pine, spruce, fragrant poplar bushy large grassy-forb-small reed valley forests.
    38a. Birch and aspen-birch with poplar grass-small reed communities.
    Pine forests (Pinus sylvestris)
39. Pine and larch-pine rhododendron (*Rhododendron dauricum*) with spirea (*Spiraea media*) small reed-forb and bracken (*Pteridium pinetorum*).
40. Pine, larch-pine gramineous-forb and cowberry-forb forests with steppefication sections of steep southern slopes.
    40a. Birch gramineous-forb and cowberry-forb derived communities.

Swamps

41. Mesotrophic bogs and oligotrophic moors sedge-bog mosses with sparse tree layer (spruce, larch) at plateau.

Submontane depression communities
Forests
Dark coniferous

42. Fir-Siberian stone pine with spruce bilberry true mosses (*Pleurozium schreberi, Hylocomium splendens*) and bilberry short grass (*Trientalis europaea*, *Maianthemum bifolium, Mitella nuda, Oxalis of acetosella*)-true mosses submontane flat forests at low watersheds
    42a. Birch forb-bilberry derived communities.
43. Siberian stone pine-spruce with fir, larch and birch bilberry-cowberry-forb true mosses forests at mountain aprons within the slope lower parts.
    43a. Larch and Siberian stone pine-larch with birch cowberry-forb and cowberry-true mosses derived communities.
    43b. Birch cowberry-bilberry-forb derived communities.

Light coniferous forests (Larix sibirica, Pinus sylvestris)

44. Pine-larch and larch-pine cowberry-forb and gramineous-forb forests of gently sloping southern slopes.
    44a. Birch gramineous-forb derived communities.
45. Pine-larch and larch-pine rhododendron (*Rhododendron dauricum*) and forb-bracken forests with the sections of exposure steppes of the steep slopes of light aspects.
    45a. Birch grassy derived communities.
46. Larch and pine-larch gramineous-forb and cowberry-forb, by places derived birch forests, plain forests.
47. Spruce-larch bushy grass-mosses forests with sections of lowland sedge swamps and meadows at valleys.

Bushy brushwood

48. False subgolets brushwood of mountain pine with *Rhododendron aureum* sedge (*Carex macroura*)-short grass-lichen-mosses.
49. Willow-ernik (*Betula fruticosa*) with spirea (*Spiraea salicifolia*) forb mossy.

Meadows

50. Gramineous-forb with rarefied small-leaved forests and sedge eutrophic swamps of submontane plains.
    Swamps
51. Oligotrophic moors and mesotrophic bogs sedge-sphagnum and subshrub (*Ledum palustre*, Vaccinium uliginosum, *V. vitis idaea*, *Oxycoccus microcarpus*)-sedge-sphagnum with open woodland with Siberian stone pine, spruce, birches of submontane plains.

Anthropogenic formed areas

52. Ruderal and cultural communities of residential areas.
53. Agrocenosis.

III. Spatial Cenosis Structure

The complex spatial cenosis forests structure of the southwestern Baikal area is caused by the existing contrasting natural conditions, connected with

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the mountain nature of relief, by the Lake. Baikal influence, and it is complicated by anthropogenic impacts. Territory is characterized by the fold-block mountains, composed by the metamorphic rocks of Precambrian complex, and also by the contact of mountain morphostructures and basin of the Baikal Lake, whose tectonic development still continues. General regularities of spatial distribution are connected with altitudinal zonality, the exposition effects, the characteristics of local ekotopes, which determine the structure of biogeocenosis of the Khamar-Daban ridge, of the spurs of the Eastern Sayan and of the Olkhinskoe plateau. Two physical geographical oblasts were allocated here: Southern-Siberian mountain (A) and Baikal-Dzhugdzhur mountain taiga (B), within theirs landscape okrugs are represented by the specific spatial regional topological spectra (pattern) of geosystems (Fig. 2).

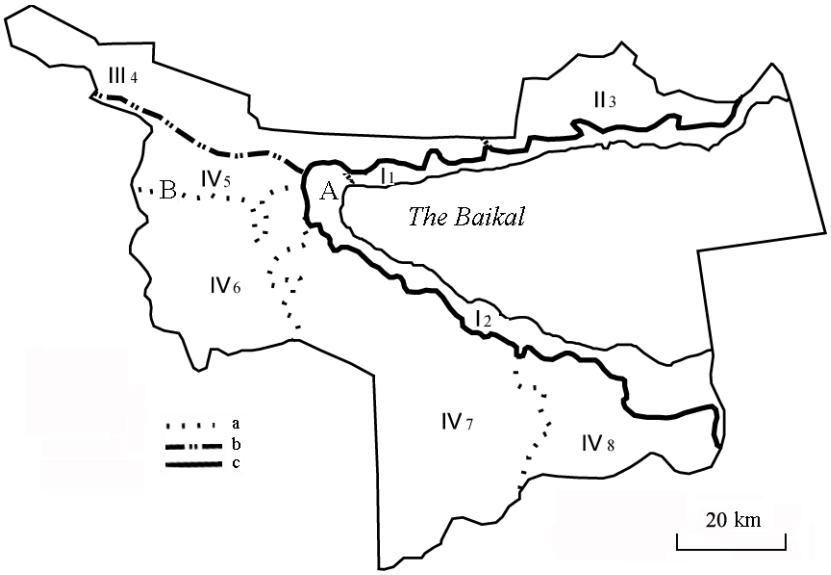

Fig. 2: Physical geographical subdivision of Slyudyanka administrative region

Physical geographical oblasts: A - Southern-Siberian mountain, B - Baikal-Dzhugdzhur. Provinces: I - Pribaikalskaya (Cis-Baikal) goletz-mountain taiga (subprovince of the Baikal lake basin), II - Verkhnepriangarskaya (the Angara upper reach) marshy with steppe formations and subtaiga submontane, III - Okinsko-Sayanskaya mountain taiga and goletz, IV - Dzhidinsko-Khamar-Dabanskaya mountain taiga and depression. Landscape okrugs: I1 — Southwestern coastal mountain taiga, I2 - South-Baikal taiga submontane-plain, II3 – Kitoi-Angara submontane-subtaiga, III4 - Onot-Taisuk middle mountain dark- and light- coniferous taiga, IV5 – Tunka depression steppe formation-subtaiga, IV6 - Zun-Murin goletz-mountain taiga, mountain taiga, IV7 – Utulik mountain taiga goletz, IV8 – Khara-Murin goletz-mountain taiga. Boundaries: a – landscape okrugs, b-provinces, c – physical geographical oblasts.

In the center of Eurasia almost predetermines climate with the cold winter and relatively warm moderate-moist summer. The action of middle latitudes air masses is manifested during the year. Mean January temperatures in the high mountain part –20.–25 of °C, July — 10–17 °C. In the coastal part because of the lake winter there is about 8–10 °C warmer than in the more remote regions, and it has cooler summer. Because of the orographical heterogeneity contrasts in the precipitation are observed. Their distribution is connected with the altitudinal zonation, and also with the local ridges arrangement, which intercept precipitations of the ruling of north western air mass transfer. If in the mountains at a height 1200–1500 m a.s.l. it falls out about 1500 mm, but on the coast of lake (455 m a.s.l.) — about 400 mm, and on the eastern, inverted to the Baikal slopes of Olkhinskoe plateau in the north-eastern part of the region — about 300 mm.

The Southern-Siberian mountainous oblast, which represented with three provinces of distinguished landscape structures, occupies major portion of the administrative region territory as area study. From them Dzhidinsko-Khamar-Dabanskaya mountain taiga and depression province (IV) has the greatest area. It is differentiated into four landscape regions (5–8), which are, in turn, characterized by the peculiar spatial mosaics of geos-systems and by the spectra of altitudinal zonation from high mountains (up to 2300 m) to lower mountain taiga belt (850–900 m). Here high mountain vegetation is represented with communities of

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alpinotype meadows and mountain tundras of the South-Siberian formations of Ural-Siberian phratry.

For the southern part of the research area with the alpine form of landscapes and with the active slope processes (tooth pointed crests of ridge-spurs, erosional and glacial forms)it is more characteristic the open fragmentary groups of grassy (Saussurea pricei, Tephroseris turczaninovii, Smelowskia bifurkata) plants. In the golets belt there are approximately at the same heights extended alpine tundras, predominantly lichen, with the small sections of short grassy alpine meadows and nival small meadows.

In the high mountain northern part of the territory (Zun-Murin golets-mountain taiga okrug) golets geosystems with flattening relief forms and gently slopes dominate. The surfaces of plateau are occupied with stony scatterings and alpine tundras: stony, stony-dryad, lichen, mosses-lichen, sedge-mosses. On the golets with the flattened surfaces and gently slopes there are extended mossy (*Aulacomnium turgidum*, *Dicranum elongatum*)- lichen (*Cetraria cuculata*) tundras with sections of dryad, grassy tundras and moors with the rarefied cover from bilberry (*Vaccinium myrtillus*), fillodotse (*Phyllodoce caerulea*), rhododendron of Adams (*Rhododendron adamsii*), bergenia (*Bergenia crassifolia*) and the lichens of the Stereocaulon. In the upper part of the southern slopes the small sections of desert type alpine meadows are noted with the dryad, rarely - kobresia moors.

The geosystems dynamics is connected also with the processes of bogging up and peat forming on the watershed depressions and on the solifluction slope terraces covered with sedge (*Carex bigelowii subsp. ensifolia*) and with cotton-grass (*Eriophorum sp.)* communities.

Along the slopes of water-collecting lows and the gently sloping sections of the blown snow-patches with mountain-medow soils there are formed the characteristic south-siberian subalpine luxuriant forb meadows (*Aquilegia glandulosa*, *Viola altaica*, *Campanula dasyantha*, *Diphasiastrum alpinum, Doronicum altaicum, Ciminalis grandiflora, Carex atterima, Pedicularis amoena, Hierochloe alpine, Geranium krylovii*).

Lower located subgolets sparse woods are characterized by the propagation of dark coniferous forests with fir tree (Abies sibirica) and Siberian stone pine (*Pinus sibirica*).

In the western part of the territory, within Zun-Murin golets-mountain-taiga landscape okrug (6), the subgolets belt was formed by sparse woods with Siberian stone pines and larches (*Larix sibirica*) having ground birch underbrush (Betula rotundifolia). The single plants of the larch dwarfish form are observed up to 2000 m height and more. At the same altitudal level as sparse woods and above there are some places of ground birch brushwood and, by places, especially on the southern slopes, — the brushwood of Adams's rhododendron. Subalpine and alpine meadows occupy insignificant areas.

At the forests border within subgolets belt there are extended fragmentary and compact mountain pine communities of Baikal-Dzhugdzhur formation of Bering phratry, which occupy predominantly the slopes of northern aspect. Mountain pines (*Pinus pumila*) form high density brushwood with height about 1,5 m and with single Siberian stone pine and fir. In the underbrush rhododendron golden (*Rhododendron aureum*), subshrub cover from bilberry, crowberry (*Empetrum nigrum*), cowberry (*Vaccinium vitis-idaea*), and Adams's rhododendron predominate. Grassy forms almost are absent, projective cover is about 5 %. They are encountered bergenia (*Bergenia crassifolia*), may-lily (*Maianthemum bifolium*), from characteristic alpine plants – alpine whitlow grass (*Draba alpine*). Mossy cover is near 80 % (Hylocomium splendens, Aulacomnium sp.). Peaty-gley soils with peat horizon about 10 sm. Soil profile depth reaches 45 cm, ferrugination is observed in the middle part of the profile, the skeletal nature of soil substratum is expressed. Thus, near The Grassy summit (1550 m) such complex is located within altitude range 1530–1550 m and has relatively small area. It is located on the northern slope of narrow watershed with about 35° steepness which has stony outcrops of gneisses. Subalpine meadows are noted at the same heights on the southern slope of the same watershed in the upper part of the water-collecting low.

Below, in the altitudes range from 1000–1050 to 1470–1500 m, it is characteristic the propagation of fir mountain park type woods, taking place of relatively gently sloping slope- watershed surfaces with inclination 7–10°. The mesorelief of such locations is nival-fluvial formed as a result of refreshing freezing-thawing processes influence throughout year and loose surface deposits. Mountain forest turf medium-loamy soils are developed on the eluvium of the carbonate rocks, but they are lixiviated. Their depth is about 0,5 m, it is expressed gumus soil profile, skeletal nature of profile increases from depth 0,2 m.

Arboreal layer consists from fir tree and Siberian stone pine (standing formula 8Fir2Pine), the height of trees is 6–8 m, diameter 20–25 cm, crowns cover - 0,2. The renewal of tree standing is not marked. Grassy cover is gramineous-forb (moist grassy) with projective cover 80–100 %. Wood millet (*Millium effusum*), small-reed (*Calamagrostis obtusata*), geranium (*Geranium sp.*), violet (*Viola uniflora*), Siberian globe flower (*Trollius sp.*), hellebore (*Veratrum lobelianum*) have great abundance. The groups of Siberian stone pine with cowberry-bergenia cover takes places with gneisses outcrops.

Major part of the entire area is occupied by slope geosystems of mountain taiga belt with South-

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Siberian communities where fir and Siberian stone pine dominate, and also their derived communities with larch, pine (*Pinus sylvestris*) and small-leaved species (*Betula platyphylla, Populus tremula*), extended to a height 1400–1450 m. They are bilberry, cowberry, short grasses (*Trientalis europaea*, *Maianthemum bifolium*), true mosses (*Pleurozium schreberi, Hylocomium splendens*) communities predominating. On the slopes of light exposure Siberian stone pine grassy forests prevail, on the shady — Siberian stone pine and fir with spruce (*Picea obovata*) marsh tea (*Ledum palustre*) true mosses.

For north-eastern, inverted to the Baikal macroslope of Khamar-Daban ridge it is characteristically significant propagation of fir tree, by places including shoots renewal, and it is typical the preserved relicts of the grassy plants of tertiary broad-leaved forests.

Composition of the forest communities of northern macroslope of Khamar-Daban ridge is differed by first of all the large presence of larch and the altitudinal shift of the boundary propagation of mountain taiga light coniferous forests. In this case the larch is extended to upper boundary of subgoletz belt. The lower mountain part of Zun-Murin landscape okrug is presented with larch forests: in common pine-larch small reed-forb communities which upwards are changed by cowberry-grass with the rhododendron dahurski (*Rhododendron dahuricum*), larch cowberry-marsh tea-mosses and Siberian stone pine-larch. And above Siberian stone pine subshrub-mosses forests grow.

Valley geosystems are ernik with riverside brushwood of willows, and also with sections of steppefication and swampy with carex-like kobresia (*Kobresia sp.)* meadows.

Mountain taiga communities of Southern-Siberian type occupy coming from the north outlying outspurs of Eastern Sayan with erosional-denudation low-mountain relief and heights of up to 1300 m and Olkhinskoe gently undulating plateau with height of up to 900 m (Okinsko-Sayanskaya province).

On the spurs of Eastern Sayan up to height about 900 m (the southern slopes to 1100 m) there predominate communities of light coniferous forests, which upward along the slope are replaced by dark coniferous mountain taiga, and else above they are changed by Siberian stone pine subgolets sparse woods. Here the watershed territories of flattened manes are represented with equifinal states of dark coniferous taiga with supremacy of Siberian stone pine communities - subshrub (*Vaccinium myrtillus, V. vitis-idaea*), short grass (*Trientalis europaea*, *Maianthemum bifolium*) politric-true mosses (*Pleurozium schreberi, Hylocomium splendens)*.

At dominating gentle slopes of Olkhinskoe platea (Verkhnepriangarie province) there are predominated recovered states of dark coniferous communities as light coniferous (*Larix sibirica, Pinus sylvestris*) and small-leaved rows of middle age and ripen with developing undergrowth of dark coniferous tree species (*Pinus sibirica, Abies sibirica, Picea obovata*), mainly Siberian stone pine, which have stable prolonged derived character (grassy, short grass-cowberry-true mosses and cowberry-marsh tea-politric-true mosses, at lower slope parts with sphagnum mosses). Distinctly there are manifested the exposure differences (north-south), expressed in variability properties of vegetation and soils.

The valleys of middle and upper reach of rivers, influent into the Baikal, are wide, planoconcave, bushy covered and frequently swamped. Bogging up in the planoconcave upper reaches of small rivers (actually this is interfluve) can bear mesotrophic or even oligotrophic nature as, for example, in the upper reaches of the Bolshaya Shumikhar-river, where in the plateau there is located sedge-sphagnous uneven raised bog with small pools swamp. The soils are peat and with longterm permafrost. Wood layer spare-stand is low-quality appraisal, with crowns cover of 0,1–0,2. It consists of larch, Siberian stone pine, spruce and birch with quantitative predominance of Siberian stone pine. In underbrush there are sweetbrier (*Rosa acicularis*), subshrub layer is great bilberry-marsh tea with cowberry and the large cranberry (*Oxycoccus microcarpus*). The mossy continuous cover consists on 60% of sphagnum mosses with impregnations of true and politric (*Polytrichum commune*, *Pleurozium shreberi, Ptilium crista-castrensis*) and lichens of *Cladonia* kind.

Submontane forests of the adjacent to the lake steep southern slopes and slopes of the intermediate exposure (Southwestern coast mountain taiga okrug) include pine with larch rhododendron (*Rhododendron ahuricum*), cowberry, forb-bracken with steppefication communities and with sections of exposure steppes. Area of steppe formations along the coastline slopes of the Baikal is elongated almost without breaks about 80 km with removal from the lake by places through the mountain river valleys by 2–4 km. At steep southern coast slopes with rocks outcrops steppe formations most probably has natural origin, caused by the activity of contemporary exogenous processes and by the absence of snow cover in winter. The sections of the steppe appearance have sedge-gramineous-forb in composition of grassy layer, wormwood -forb with chernozem-like soils, they contact within sloping gullies and depressions with meadow-forb cover, and also with pine and larch-pine forests of cowberry and forb with underbrush of dahurski rhododendron at more gently slopes.

The primary forest structure of this part of the Baikal coast is disrupted by fellings and forest fires, and inherent main background of contemporary vegetation composes of birch and aspen-birch forb forests. The

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slopes of different steepness near settlements are used for homestead sections and cattle pasturing. On the watersheds with the cut forests or on the bottoms of valleys there are located the small sections of haying land.

The fragment of mountain depression subtaiga landscape with steppe formations at slopes is represented within Bystrinskaya and Torskaya depressions, connecting Tunkinskaya and Baikal depression (Tunka depression steppe formed-subtaiga okrug). Climatic conditions here are more arid, that caused by depression location and isolation from the action of the advective processes, transferring moisture. Subtaiga light coniferous forests predominate, they are strongly disrupted and partially substituted by derived small-leaved communities. Submontane inclined plains of both depression sides are covered with larch and pine-larch small reed-forb forests. Also here at the slopes of southern aspect there are extended steppe formed-grass larch forests and fragments of real steppes. On sandy ouvals there are dry steppe formed pine forests with sparce grassy cover with black-berried cotoneaster (*Cotoneaste rmelanocarpus*), rhododendron daurski, Siberian pea-shrub (*Caragana arborescens*) in the underbrush. The fragments of spruce and poplar-spruce forests are encountered in the low floodlands, which alternate with the sections of meadows and brushwood of willows.

As a whole the variety of locations near the Baikal creates favorable environment for existence as for the most south-eastern center of developing of dark coniferous forests of Ural-Siberian phratry of formations (Sochava 1978), and for fragments of steppe formation, which have natural origin, and it also appears as a result of anthropogenic action.

Coastal area is subjected to the lake greatest impact. It is determined by zone of the direct climatic lake influence upon the surrounding territory. By places at flattened sections of the drained Baikal terraces were preserved dark-coniferous forests with primary structure -fir- Siberian stone pine with spruce bilberry true mosses (*Pleurozium schreberi, Hylocomium splendens*) and bilberry short grass (*Trientalis europaea, Maianthemum bifolium, Mitella nuda, Oxalis acetosella, Waldsteinia ternata*)-true mosses, and also prolonged-derived larch-Siberian stone pine communities. The short and prolonged-derived communities of a small-leaved (*Betula platyphylla*, *Populus tremula*) row are concentrated predominantly near the residential territories.

At the same time in the coastal zone there is noted the manifestation of false goletz belt with the vegetation elements of the Baikal-Dzhugdzhur formation in brushwood in the form of the local spots of mountain pine with golden rhododendron and bilberry lichen-mosses participation (withinin the South-Baikal taiga submontane-plain okrug).

In the flattened submontane plain at the foot of Khamar-Daban ridge there are extended oligotrophic swamps and mesotrophic bogs of sedge-sphagnum and subscrub (*Ledum palustre*, *Vaccinium uliginosum*, *V. vitis-idea, Oxycoccus microcarpus*)-sedge-sphagnum with open woods of Siberian stone pines, spruces, the birches, which, judging by the structure of the peat deposits and its botanical composition, were formed on the spot of large in the area shallow lakes (Novitskaya 1981).

In some locations of northeastern Khamar-Daban ridge macroslope as a result of specific mesoclimate there were created favorable conditions for some species retaining with particular kin connections and areas, which testify about the propagation in the past in this territory of the Baikal Siberia of coniferous-broad-leaved forests. The most of these species dwell in the dark coniferous (firry and Siberian stone-fir) forests and in the brushwood of the riverbed of the Bezymyannaya, the Utulik, the Babkha, the Solzan, the Langutay, the Khara-Murin, the Slyudyanka, the Snezhnaya, which characterized by increased humidity, rich soils, frequently with well manifested humus horizon. There are encountered male fern (*Dryopteris filix-mas*), enchanter's nightshade (*Circaea caulescens*), prominent (*Corydalis bracteata*), valdshteinia (*Waldsteinia ternate*), Baikal anemone (*Anemone baicalensis*), monkshood (*Aconitum sukaczevii*), dwarf bay (*Daphne mezereum*), wood falcebrome (*Brachypodium sylvaticum*), fescues (*Festuca altissima* and *F. extremiorientalis*), mountain bladderfern (*Oreopteris limbosperma*), Hancock's sedge (*Carex hancockiana*), fragrant bedstraws (*Galium odoratum*) and small bedstraw (*G. triflorum*), lady's slippers (*Cypripedium calceolus*, *C. guttatum*, *C.* macranthon). In the high mountain belt within the subalpine tall grass meadows, nival small meadows under the more extreme conditions there are encountered rhaponticum (*Fornicium* carthamoides), mountain willow-herb (*Epilobium montanum*), medow-grass (*Poa remota*), saxifrage (*Chrysosplenium baicalense*).

On the ledges in the cliff foots and at the riverbanks with pebble and sandy sustratum there is physochlaina (*Physochlaina physaloides*). Endemic species of the Baikal region are tussock-grass (*Deschampsia turczaninovii*) and cherepoplodnik (*Craniospermum subvillosum*) growing on the riverbed sands and the pebbles. Furthermore, for Khamar-Daban ridge there are typical narrowly local endemiks: svertia (*Swertia baicalensis*), monkshood (Aconitum sukaczevii), poppy (*Papaver turczaninovii*), tridaktilina (*Tridactylina kirilowii*). The rare species of the southwestern Baikal region have different status of protection and are included in the Red Books of different levels (Krasnaya kniga Irkutskoi…2010; Krasnaya kniga Rossyiskoi…2008).

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Regional natural complex, which was formed under the conditions of northern and eastern macroslopes of Khamar-Daban region, is unique. The high air humidity in summer and depth snow cover in winter create favorable conditions for the growth and domination of dark-coniferous taiga in the mountain taiga landscape okrugs (Suvorov 2002).

The species, composing dark coniferous forest group, possess at present the extensive Eurasian broken area. This was served as the proof of the myocene detachment of the dark coniferous taiga formation in the upper mountain belt from the Arctic Tertiary flora. The selection of species took place through whole period of dark-coniferous taiga existence (Malyshev and Peshkova 1984). Within the other territory of the Baikal Siberia with the low air humidity, contrasts of daily and seasonal temperatures, development of the seasonal and permafrost condition these conditions were, apparently, unfavorable for such species settling.

IV. Assessment of Forest Communities Sustainability

For revealing of contemporary area state, assessment of sustainability, functional connections between the components and composite parts of geosystems ecosystem approach has the most importance, its examines "ecosystem in the geographical medium" (Sochava 1978, p. 73). It is treated as revealing of interaction of biota, its elements and environment. Ecosystem approach is developing within the realm of the sciences of biological and geographical cycles: the landscape ecology (Forman 1986), landscape study (Sochava 1978; Mamai 1992), researches of vegetation and ecosystems (Schlueter 1987; Waide 1987; Shelyag-Sosonko et al. 1991; van Andel 2002; Kolomyts and Sharaya 2013).

The state of elements of physical geographical structures, landscape units of different levels is connected with the existing ecosystem connections, their manifestation in the longterm dynamics through the realization of the manufactured and fixed ecophysiological and genetic properties of plants in the prevailing ecologically differentiated environment.

Ecosystem sustainability depends on the comprising biotic components and stable existing system communications and living environment. Thus, variety and retention of plant communities within the specific territory reflects the stability of the retention of ecosystem connections. One of its characteristics-variety of flora composition.

The sustainability of vegetation is considered as the ability of plant communities actively to support and to restore its phitocoenosis structure and regimes of functioning within geosystems (Belov and Sokolova 2011), preserving in this case ecosystem relations and connections. The dynamics of plant communities realizes within the framework of their invariant, which corresponds to the existing stage of the historically prevailing conditions of the natural environment (Sochava 1979).

Under the contemporary physical geographical conditions with the prevailing diverse structure of anthropogenic actions as the basic external disturbing factor, which influences the natural trend of the forests dynamics, it is possible to divide the area into parts of the different temporary sustainability degree and conservation. The whole spectrum of this territory forest communities in the first approximation, can be differentiated to classes, which reflect their retention in up-to-date conditions. It was carried out the ranking, based on the expert assessments of plant communities taking into account their retention and degree of proximity to equifinal stages of successional conversions (table).

Table1: Integrated areas of sustainability of plant communities

Sustainability level	Plant communities indicators	Special features of development conditions and the nature of recovery
1. Stable	High mountain mountain-tundra willow-ernik and swampy sedge-cotton grass flattened Mountain pine of subgolets sparse woods Mountain taiga and submontane depression primary dark coniferous and light coniferous of slopes and of valleys Bogs and swamped meadows	Retard recovery under external disturbances. Low biotic diversity. Retard recovery after external disturbances. Ecologically favorable exsistence conditions and structure recovery. Optimal and partially limited development. Stable in spontaneous dynamics. of optimal development. prolonged-derived recovery stages under periodic anthropogenic impacts
	High mountain mountain-tundra of slopes Subgolets dark coniferous sparse woods, mountain pine communities and shrub thickets Sections of subalpine meadows and catchment lows	Retard recovery under external disturbances. Intensive slope processes Low biotic diversity. Retard recovery

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2. Moderate-stable	Dark coniferous sparse woods with meadows by places of upper belt of reduced development Dark coniferous sparse woods of reduced development upper belt, subshrub with mountain pine Mountain taiga primary dark coniferous at steep slopes Mountain taiga and submontane depression light coniferous prolonged-derived of successional stages and shrub-gramineus-forb medow prolonged-derived	after disturbances. Intensive slope processes High biotic diversity. Retard recovery after disturbances Narrow ecological species amplitude. High biotic diversity. of limited development conditions. Slope processes of limited development conditions Active slope processes. of limited development conditions of limited and optimal development conditions. Active slope processes. Under periodic anthropogenic impacts
3. Weak-stable	High mountain alpinotype short grass meadow communities Mountain taiga primary dark coniferous and sparse wood with mountain pine of reduced development upper belt at steep slopes	Narrow ecological species amplitude. Active slope processes of limited development conditions. Intensive slope processes.
4. Unstable	Mountain taiga of different altitudinal belts, including false-golets belt, of small-leaved short-time-derived successional stages Unclosed groups of grasses within high mountains with active slope processes	Favorable conditions of structure recovery. Intensive slope processes. Active denudational processes. And unstable recovery under changeable conditions
4a.Unstable anthropogenic transformed	Stable-derived communities of active land use	Stable under constant anthropogenic impact

Basing the map of contemporary state of vegetation (Novitskaya and Suvorov 2012) cartographically integrated areas of stability were represented (Fig. 3).

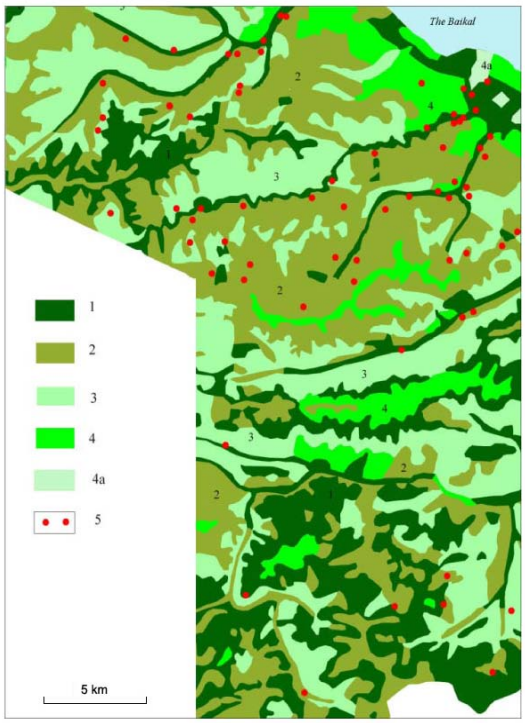

Fig.3: Fragment of the map "Sustainability of vegetation communities and ecosystems of Southwestern Pribaikalie

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Integrated areas of sustainability of plant communities and ecosystems: 1 – stable, 2 – moderate-stable, 3 – weak-stable, 4 – unstable, 4a - unstable anthropogenic transformed. 5 – rare species locations.

To stable it is related the plots of the preserved different types forests and other communities, due to their dynamic state close to primary states with the ecologically tolerant conditions for existence and structure renewal, for which is characteristic the stability of spontaneous dynamics, but at the same time retarded recovery after external structure disturbances. There equifinal succession forms of communities prevail.

To moderate-stable there are related the sections with the primary and prolonged-derived communities with active manifestation of the repetitive external factors of action, predominantly in the form of exogenous processes, which have an effect on background spontaneous dynamics. For them there is also peculiar retarded recovery and mainly limited development.

For the weak-stable sections it is characteristic the factor limited conditions for development, due to the narrow ecological range of plant communities existence and also caused by active exogenous relief processes.

To unstable it is related the sections with short-derivaed communities of restoring states of the different types of mountain taiga geosystems and with the high mountain communities under the extreme ecological conditions, and of also anthropogenic ally changed with the stable-derived communities of land active use.

The cartographically obtained integrated areas of sustainabiolity include different ecosystems, which have various mechanisms of the structure retention. Their uniting property is confinement to territorially compact areas with the retention of the existing structure. The high fragmented mosaic structure of the centers of the propagation of primary forest communities contributes to their steady retention.

V. Conclusion

For major part of the south Baikal area it is characteristic the domination of stable and moderate-stable preservable for estcommunities, extended in the mountain taiga belt of optimum development and the upper mountain taiga belt of limited development. Mosaic-dispersed distribution of forest communities of equifinal succession stages testifies about the up-to-date favorable conditions for retaining the dark coniferous forests in this region.

Anthropogenic impacts are noted mainly in the coastal zone along the railroad and the highways and next to the populated areas. There are concentrated the forest communities, which present in majority short-term-derived stages of the succession recovery. Their existence, especially near the large populated areas, is stable with the permanent anthropogenic press, and they remain long time as stable prolonged-derived communities.

The weak-stable and unstable mosaics of areas are almost continuous in lower mountain taiga belt and within adjacent submontane plains with sections of Baikal terraces. The propagation here of relict and rare plant species, which find favorable conditions for the growth, testifies about their unstable position as a result of anthropogenic press encreasing. It is necessary the complex assessment of location conditions and of state of plant populations at large-scale topological level. The territory of active anthropogenic action, including up-to-date economic infrastructure, is attached to the lake Baikal coastal zone, and the expansion of weak-stable and unstable areas is limited to the mountain conditions of locality.

The prevailing structure of this territory nature management and spatial differentiation of forest communities of the the southwestern Baikal region characterize the unique physical geographical conditions of retaining the dark coniferous taiga on the southeast of its propagation under the mountain conditions with the unique mosaic structure of areas stability.

The presence of a significant quantity of Tertiary relicts testifies about the long duration of favorable conditions for their existence at northeastern macroslope of Khamar-Daban ridge in the comparison with the entire territory of the Baikal Siberia, and also about the long continuance of interaction of the remainders of coniferous-broad-leaved and boreal flora through Holocene. To the retention of some species in the communities of mountain dark coniferous taiga it is contributed variety and mosaic propagation of locations (ecotopes) of mountain conditions.

For optimization of the regional system of nature management it is necessary to consider both the geosystem territory differentiation, which gives conditions for the propagation of different forest communities and species, and spatial heterogeneity of the areas of stability in the relationship of primary and derived structures under existing forms and the intensity of anthropogenic action.

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Densification Scenario of Dhaka: The Role of Socio-Economic and Political Forces on Urban Planning

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Abstract- Dhaka the capital city of Bangladesh is one of the fastest growing megacities of the world with a density of 23,234 people per square kilometer (World Population Review, 2016). The city bears a legacy of four hundred years and have undergone through a series of shifting political status and dramatic changes in its population throughout the history. But since its emergence as the capital city in 1971 it had to face a huge influx of rural migrants pouring in on a regular basis. Within four decades of its inception Dhaka witnessed a radical increase in population which constitutes about 40% of the total urban population of the country and 6% of the entire national population. Due to its unique geographical constraints the city could not spread horizontally which caused a scarcity in the inventory of buildable land. Consequently the city had to grow vertically to accommodate the escalating demand of housing and other facilities which in turn increased the density. By 2011 the population of the city reached 14.7 million with one of the highest densities in the world. (World Population Review, 2016). In the face of land scarcity and a large and fast growing population that needs to be accommodated – there is sometimes little option left but to densify existing land uses which leads to the process of densification as it can be seen in the case of Dhaka. But the promised benefits of densification process did not seemed to be accrued so far.

Keywords: *densification, socio-economic drivers, building regulations, political will.*

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Densification Scenario of Dhaka: The Role of Socio-Economic and Political Forces on Urban Planning

Dr. Syeda Jafrina Nancy

Abstract- Dhaka, the capital of Bangladesh, is one of the fastest growing megacities in the world with a density of 23,234 people per square kilometer (World Population Review, 2016). The city bears a legacy of four hundred years and has undergone a series of shifting political status and dramatic changes in its population throughout the history. But since its emergence as the capital city in 1971 it had to face a massive influx of rural migrants pouring in on a regular basis. Within four decades of its inception, Dhaka witnessed a radical increase in population which constitutes about 40% of the total urban population of the country and 6% of the entire national population. Due to its unique geographical constraints, the city could not spread through horizontal expansion and therefore caused a scarcity of the inventory of buildable land. Consequently, the city had to grow vertically to accommodate the escalating demand for housing and other facilities which in turn increased the density. By 2011 the population of the city reached 14.7 million with one of the highest densities in the world (World Population Review, 2016). In the face of land scarcity and a large and fast-growing population that need to be accommodated – there is sometimes little option left, but densify, existing land uses which leads to the process of densification as in the case of Dhaka. But the promised benefits of densification process did not seem to be accrued so far.

The socio-economic and political drivers of the state always influence the Urban planning which is also true for Megacity Dhaka. The ever changing socio-economic condition of different periods guided by the political will of the incumbent rulers acted as a key driver in determining the urban growth pattern of Dhaka. Though the British can be credited for making the first Master Plan of Dhaka a significant transformation of the city as provincial capital can be witnessed from Pakistan period. The importance of Dhaka continued to grow after independence as an influx of migrants rushed to the capital which served as the sole economic hub of the country. The formulation and application of building regulations of various periods in addition to the socio-economic and political drivers have brought Dhaka to the present state of densification. Given this development scenario, this paper intends to investigate the causes of densification through identifying the influences of various socio-economic and political forces on the city planning agenda within the application period of the dominant Building Regulations.

Keywords: densification, socio-economic drivers, building regulations, political will.

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I. Introduction

From the onset of the 21st century as the world urban population was experiencing an up rise the provision of accommodating the mass through construction of sustainable megacities became a challenge for the urban planners as well as the governments worldwide. Densification proved to be a plausible solution to the crisis as it ensured the preservation of valuable agricultural land together with the benefits of energy consumption. Consequently densification was adopted as a widely practiced strategy to attain sustainability of the megacities in both developing and developed countries. Dhaka reached the status of Megacity from 2000 with a population of 10.16 million and kept on increasing since then. The city has been expanding since its inception in 1610 A.D. but never before the city had to experience the scarcity of buildable land for the growing population as it had to after independence. Soon after the independence, Dhaka became the sole of hub of economic, administrative and cultural activities owing to the centralized development policy of the incumbent Government. This in turn made people from all over the country to pour in Dhaka in search of employment opportunities making it one of crowded cities. The newly formed country had to undergo through a prevalent political instability in its initial years where due attention could not be given towards developing a well-conceived planning strategy for the capital. The lack of foresight coupled with technical incompetency in the field of urban planning gave way to the spontaneous growth of the city. Development was taking place more as a result of the socio-economic conditions guided by political will rather than informed decisions of planners. The inadequacy of the planning rules and lack of monitoring resulted in encroachment of wetlands promoting both vertical and horizontal expansion. These types of endeavors by the vested groups took place in large scale and eventually set the stage for the current complications stemming out from the current densification process. However, the ongoing densification process of Dhaka is still unguided owing largely to the lack of proper densification strategy as well as building rules and bye-laws aimed at ensuring a

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sustainable future for the city. In addition with the influences of various socio-economic and political drivers the planning instruments operating within this period also exert a profound impact on the densification process that have been taking place over the years.

II. The Impact of Existing Building Construction Rules

The building activities within the metropolitan area of Dhaka have been regulated by the Building Construction Rules (BCR) formulated by the RAJUK (Capital Development Authority) as bye-laws of the East Bengal Building Construction Act 1952. The Rules started in 1955 with only 5 lines of instruction on the backside of the application form. Gradually newer requirements were set-1 page in 1970, 3 pages in 1984, and 12 pages in 1996 (Rahman, 2011). BCR 1996 was reviewed several times and finally replaced by a newly reviewed byelaw known as Mohanogor Imarat Nirman Bidhimala (MINB) 2008 which came into operation from 2008. These bye-laws have a profound impact on the building activities rather than the overall planning rule which has brought Dhaka to the present state of densification. The following section therefore traces the development scenario of Dhaka through identifying the socio–economic and political forces within the application period of these three dominant bye laws: BCR 1984, BCR 1996 and MINB2008.

a) Development Perspective under Building Construction Rule (BCR) 1984

Before the formulation of the Building Construction Rule 1996, the only statutory policy guideline was the Master Plan 1959 which was conceived by the colonial rulers of East Pakistan Regime to absorb the sudden growth pressure caused by the migrating Muslim refugees from India after 1947. The plan was prepared following the post World War II British master plan style where the entire city was divided into a number of land use zones and was connected with a road network and other line services. These plans were rigid and did not consider the socio-economic issues of urbanization in depth. It was basically a land use zoning plan serving as zoning regulatory measures prepared on a population base of the Provincial Capital. But the sudden emergence of Bangladesh as a sovereign state and the upgraded status of Dhaka as the National Capital turned the city to be the prime commercial hub of the country. This in turn brought an influx of rural migrants to the city. For this unanticipated population increase the land use allocation and development guidelines suggested in Master Plan 1959 proved to be incompatible and inadequate. The existing Master Plan needed to be reviewed in favor of formulating a new Master Plan for the city. But the newly emerged country under the leadership of Bangabandhu Sheikh Mujibur Rahman was faced with a host of economic and political challenges. Apart from the effects of 1970s cyclone the war-ravaged country was faced with the challenge to restore its immensely deteriorating economy. The newly elected government had to focus on more serious issues like rehabilitation of millions of people displaced in 1971, organizing the supply of food, health and other necessities. Amidst all these crises the issue of city planning was subdued. The paucity of fund and a shortage of native expertise in the field of planning further delayed the formulation of the second Master Plan.

However, during this period, the city of Dhaka was stretched up to Azimpur, New market, and Dhanmondi. Azimpur was developed for staff quarters which provided accommodation to the Public service employees while Dhanmondi for housing the diplomats and elites. The residential areas of Banani, Gulshan, and Uttara were considered as suburbs with most of the plots remaining vacant, and no significant development was apparent till 1980 (interview of a senior resident of Banani, 2014). The old city core continued to be the prime urban area with CBD in Motijheel. The only Master Plan of 1959 was still in effect, but little of the plan adhered. For example, the Mirpur area was developed for accommodating the rehabilitated population predominantly the Muslim refugees according to the Master Plan. Furthermore the Master Plan conceived during the colonial occupation required a review as it was based on assumptions that became obsolete after independence. But when the average GDP growth prospect went down alarmingly to 1.5 percent due to extensive nationalization policy, the urbanization of the city met a stalemate. The precarious economic condition was further devastated by the deadliest famine of 1974 killing 1.5 million Bangladeshi people from hunger. The famine was a result of the operational inefficiency of resource distribution, corruption and bureaucracy rather than food crisis which triggered major discontent against Mujib"s government (Zafarullah, 1990). Amidst this increasing political and economic crisis no significant city development program was undertaken. The continuing economic deterioration and mounting civil disorder led to the government in adopting more strict control and undemocratic measures which ultimately caused the downfall of Mujib"s government and transition of power to Martial Law Administrators in 1976. Thus the country fell into the grip of military control for a short period when the national economy was facing uncertainty.

Assuming the presidency in 1977 General Ziaur Rahman dismantled the martial law marking the transformation of Bangladesh"s Government from the Martial Law Administration (MLA) to a democratically elected, constitutional one. There was a global rise of the neoliberal policy model in the sphere of economy and society which began in the late 1970s and was

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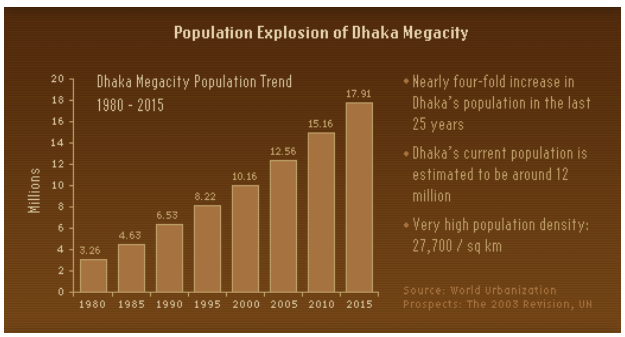
adopted by the developing countries in various stages. In Bangladesh, the market-oriented liberalizing policy reforms were initiated around the mid-1980s with the support of IMF and the World Bank (Mahmud et. al., 2007). Adopting this framework means that "urban sector" is no longer just about urban housing, infrastructure, and municipal services delivery. It is also about economic growth, and job creation (e.g., ADB 1995; WB 2010). Two key features of this new paradigm are the emphasis on devolved local governance and the reliance on the private sector. These features require a host of institutions and laws, secured land tenure, a capital market, and arrangements for private sector role in municipal services. To overcoming the declining economic condition, the government embraced the neo-liberal policy model and introduced free markets. Overtime donor-initiated privatization, and structural adjustment policy (SAP) was adopted (Bhattacharya, et.al. 2001). This strategy helped to restore the badlv affected economy of the previous regime for the time being and was reflected in the GDP which rose to 4.1 from 1.6.

Along with crawling towards a democratic order, the civil-military bureaucracy ran and managed the state of affairs along with widespread and frequent criticism of the bureaucracy on the charges of corruption, lethargy, and malpractice (Ahmed, 1995). A reviewed Master Plan was long overdue but due to the persistent economic instability and administrative turmoil, no remarkable initiative was made to evolve a mechanism for effectual urban planning of the city during Zia regime. Dhaka continued to be the main economic hub of the country. The first commercial high rise building was constructed in Motijheel. Sangshad Bhavan in Sher-e-Bangla Nagar was completed, and the developmental work of satellite towns was going on at a slow pace according to the Master Plan 1959. But as the planning considerations of 1959 Master Plan was proven insufficient and it failed to provide a successful growth strategy for the city. However, one of the chief contributions of this Master Plan was the laying of the 8 major road arteries that determined the future growth axis of Dhaka towards the north. The developmental work again came to a pause due to political turbulence caused by Zia"s assassination in May 1981.

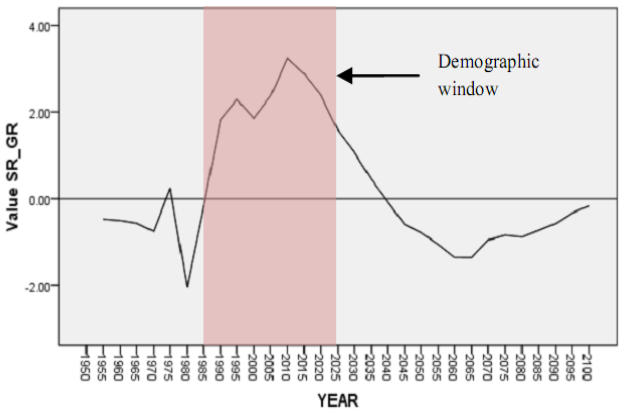


Source: World Urbanization Prospects: The 2005 Revision, UN

Chart 1.1: Population Explosion of Dhaka Megacity

The administration was immediately succeeded by President Justice Abdus Sattar for a brief period. The to the tune of 4 billion Takas, and the International Monitory Fund (IMF) declared that it would not provide any more loans until Bangladesh paid down some of its existing debts. Citing the country"s social, economic and political crisis, General Hossain Muhammad Ershad assumed the presidency in 1982, retaining his positions as Army chief and CMLA. From August 1975 to December 1990, Bangladesh experienced the rule of two consecutive military regimes – Zia regime (1975-1981) and Ershad regime (1981- 1990).

During this long 15 years, the two military rulers had tried to tinge their regime with civilian color by holding elections and running the parliament. The autonomy instilled by them has left a significant impact on the socio-economic condition of the country discussed in the following:



Source: UN (2010). Medium Variant

Chart: 1.2 Growth Rate of Support Ratio (Per cent) Bangladesh: 1950 – 2100.

The 1980s decade was governed with political autonomy but with positive development in the economy. Right before the bloodless coup led by the Army Chief of Staff Lieutenant General Hussain Muhammad Ershad the country was going through great economic difficulty. Among his first actions were to privatize the largely state-owned economy (up to 70% of industry was in public ownership) and encourage private investment in heavy industries along with light manufacturing, raw materials, and newspapers. Foreign companies were invited to invest in Bangladeshi industry as well, and stiff protectionist measures were put in place to safeguard manufacturing. Bangladesh has been going through macroeconomic policy reforms along neoliberal lines since the late 1970s. The liberalization policy graduated in three steps in the mid-1980s, early 1990s and mid-1990s, steering Bangladesh"s economic policy in a dramatically opposite direction. Subsidies for agricultural inputs were gradually withdrawn since the early eighties (Ahmed, 1998). Several rounds of industrial policies saw more

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and more sectors opened up for private entrepreneurship while privatizing the state-owned enterprises. As a part of the same package, there was a reduction on import tariffs were reduced with profound impacts on the pattern and composition of the manufacturing sector in the country (Mahmud, 2004). All these steps initiated a change in the occupational pattern as more people were getting involved in the secondary and tertiary sector. The consequences of this shift in occupation was reflected in the urban planning of Dhaka as new CBDs along the north axis started emerging providing jobs for these emerging working class.

According to demographers, Bangladesh entered the demographic window from the 1990s which is defined to be that period in a nation's demographic evolution when the proportion of the population of working age group is increasing, and dependency ratio (ratio of dependents to working-age population) is decreasing. The demographic window of opportunity usually lasts for 30–40 years depending on the country"s fertility rate. In case of Bangladesh, the demographic window will reach its peak during the 2020s and will remain open until the 2030s according to the estimation of UN2010 (Chart 1.2). Consequently being the economic nucleus of the country Dhaka has already witnessed the unprecedented growth in its share of the urban population due to natural growth as well as rural migration. This boost in the proportion of working age population subsequently led to a phenomenal increase in housing demand (informal and formal sector) of the city. This increasing demand for housing could not be ensured by the Government alone and had to rely on the private sector. Adopting the policy model of neo-liberalism, the government continued to maintain the role of facilitator rather than provider in case of provision of the formal housing. The escalating demand for housing brought the attention of the investors in the real estate market. The prevailing subdivision law did not allow land to be subdivided below 3600 sqft in the formally planned residential areas. This ceiling posed a problem for dividing the land equitably among the legitimate heirs according to the Muslim law of inheritance which led the beneficiaries to find a solution through the way of constructing multistoried buildings. In a multistoried building, each inheritor gets a fair share regarding the number of apartments which he or she can use for self-accommodation as well as use the rest for rental purpose. Consequently, more and more property owners of the planned residential areas started redeveloping their land or property into multistoried buildings which offered a means of both accommodation and profit making. Both the landowners and developers found this type of redevelopment activity beneficial and were engaged in deals of 40-60 percent share. From 1980 to 1990 the population of Dhaka doubled which further escalated the demand for housing and shelter. In the face of land scarcity, the rising demand for housing was tackled through vertical development first introduced in Dhaka by the formal private developers in mid-70s. The business took off with five registered firms. The first high rise apartment built in Siddeshwari marked the initiation of apartment culture. The main impetus of the real estate developers in housing provision was undeniably profit making. To achieve their goal of profit maximization the developers primarily catered the housing need of the upper income group (i.e., higher middle and middle income) Furthermore, the inflow of foreign remittance from the non residing Bangladeshies contributed to this type of housing scheme as they found it profitable to invest in the real estate market where both land and housing could be foremost vehicles of speculation. Government"s initiative in developing various satellite towns accelerated this process where a majority of the allotted plots went under the ownership of the wealthy class who harnessed it as a means of speculation. As the developers" activity was gaining momentum a gradual but steady rise in the population of the satellite towns of Banani and Gulshan could be observed from the early 1990s while Uttara was still undergoing the development phase with most of its plots still vacant.

b) Development Perspective under Building Construction Rule (BCR) 1996

The decade of the 90s witnessed the transition from autonomy to democracy following a mass protest that ends the long era of dictatorship. The first half of the decade (1991-96) was under the rule of the democratically elected Bangladesh Nationalist Party (BNP). Soon after assuming the power BNP met with a host of challenges. Khaleda regime initiated a series of measures to liberalize the economy and the financial sector. The structural adjustment policy (SAP) of the World Bank and the International Monetary Fund (IMF) envisaged inter alia deregulation of the private sector, improvement of Government-Business relations and privatization of public enterprises. Thus a distinct shift in the role of the government was becoming more apparent from a regulator to that of facilitator in economic management (World Bank and Ahmed cited in Zafarullah, 1997:5 Part-4). This further fueled the involvement of private sector in housing supply. The small number of developers who started haphazardly in mid 1970s consolidated into more organized form under the umbrella institution of Real Estate and Housing Association of Bangladesh (REHAB) in 1991 with 19 members.

Despite a shift in the form of government, the country faced widespread corruption and sudden changes in economic practice in the years 1990-92. Besides, a host of natural calamities (eg., cyclone Cidar and subsequent flooding) also took a toll on the national economy. Consequently, investors were not interested in

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investing during this economic downturn. So, during this period the country faced a recession in the real estate market as well since the Real estate is heavily dependent on investors. Amidst these political and economic crises, little attention from the government was paid to the developmental works of the city. However, the long-awaited second Master Plan DMDP 1995 was formulated at the end of the BNP administration when the government was facing a general strike aimed at forcing the resignation of Prime Minister accused of corruption and competence. Against such a backdrop of political unrest and shortage of time, the government was not able to accomplish its implementation. There was again a change in the ruling political regime as Awami league wins the power seat after BNP"s five years tenure. During the ruling period of the Awami league (1996-2001) most of the policies suggested in the Structural Plan of DMDP 1995 was not carried out properly due to the absence of Detail Area Planning (DAP). Instead, piecemeal planning solutions were worsening the city"s growth plan. After the recession of 1990-92, the real estate business gradually took off. But due to the lack of a complete development planning package for the city the redevelopment activities of the private sector were concentrated in the planned residential areas like Dhanmondi and later spread to Banani and Gulshan without taking into account the infrastructure capacity and amenities necessary for supporting such development.

The haphazard construction of mid and high rise buildings initiated vertical growth within the city, and the authority faced the challenge of providing adequate utility services to meet the demand of these vertical habitats. As the existing Structure Plan (SP) and Urban Area Plan (UAP) was not helpful enough to control the redevelopment spree that was taking place, RAJUK sought the aid of Building Construction Rules and framed the BCR 1996 which viewed a building only within its plot boundaries, using no tool but the setbacks and later imposed a height limitation of six stories based on road width and a few other requirements for vertical development. Though better in many aspects than BCR 1984, the BCR 1996 did not take into account the environmental considerations of the building activities and therefore was a prime cause of the emerging densification pattern, i.e., the densely developed 6-storied high multistoried buildings all through the city in the later years. However, the gradual increase in investment following the recession of 1990-92 resulted in an immense supply of this prototype vertical housing in the real estate market during 2004-06. As a result, the land price shot up unrealistically making housing price beyond the affordability of the mass public. The real estate business attracted investors by providing lots of good products. Subsequently, many new entrepreneurs lacking relevant experience and adequate infrastructure support also became interested to invest in this sector. However, the real estate sector contributed by adding incremental output in the real economy on the supply side, while also bringing up demand from newly-created employment and income, preserving real sector stability. This input in the national GDP even strengthened the industry"s existence as a major provider of housing.

By the time a discernible transformation due to globalization can also be observed taking place in the socio-cultural sphere of the country. The advent of communication technology through the launching of cell phones, satellite TV, and internet services at public disposal had an enormous impact on the cultural values, customs and living pattern of Bangladeshi people. Ahmad (2004) noted that the high intensity of invasion of the household could be attributed to the global electronic media, particularly television. The response towards technological revolution was changing not only the thought process but also the living systems, consumption patterns, and even the very nature of such human desires as love and sexuality (Rahman, 2014). This cultural hybridization started from the 90s, and within a couple of years, a perceptible change was evident in people"s way of living. Behavioral pattern and lifestyles in Bangladesh got a new form influenced by Western culture. The reflection of invading Western cultural values and practices could also be observed in the family structure where the emergence of the nuclear family was gradually outnumbering the traditional extended and joint family. Most of these nuclear families (parents and one or two children) prefer to dwell in flats with two or three rooms. From the field survey 2014 nearly half of the apartments built by the developers in the case study areas were found to be between 1,000 to 1,600 square feet which are ideal habitats for the emerging urban nuclear families. Besides economic condition, this socio-cultural transition also worked as an influential factor that made urbanites of Dhaka particularly the higher middle and higher income group to adopt apartment culture quickly. On the other hand, only 2% of the residential apartments provided by the private sector is less than 700 square feet, which indicates that the real estate sector has not reasonably been able to address the low- income dwellings.

Nevertheless, the apartment culture soon gained popularity within the affluent class for various reasons. Firstly, as mentioned earlier in this section, the prevailing subdivision law of land promoted the new generation of property owners to opt for apartment construction which ensured them both shelter and a steady source of income. Secondly, the hike in land price and the cumbersome process of construction caused most people to shift their interest towards preferring apartments. Thirdly, the redevelopment activities of the existing planned residential areas offered opportunities for the middle and higher middle- income

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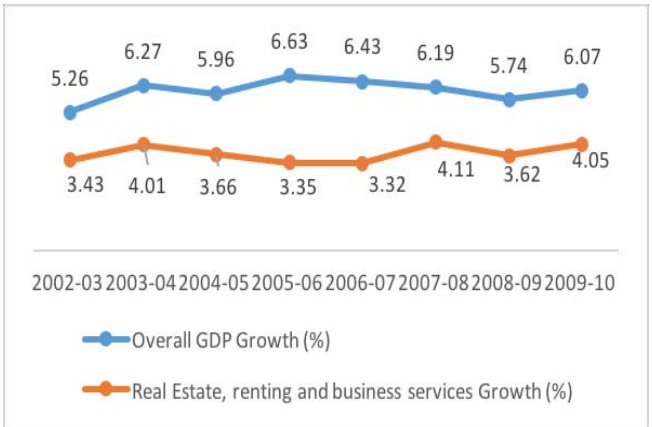
group of the old city core as well as other parts of the city to relocate into these high-class residential areas with better facilities and connectivity in pursuit of improved lifestyle choices and status. Lastly, the declining microeconomic condition along with the inclination towards westernized lifestyle worked as catalysts in changing people"s preference from detached low rise dwelling to high rise apartment. Furthermore the visual appeal and living standard of the ready to use flats as well as the security and facilities offered in vertical habitats played a central role in the popularity of apartment culture. Moreover, the issue of safety and security of apartments is another factor for preference since it has been obligatory for an apartment building community to have a management consisting of the apartment owners responsible for the overall building. All these reasons have been shaping the apartment buyers' decisions and preferences. Again the significant number of absentee property owners, i.e., the wage earners in the Middle East and other foreign countries are also the potential buyers as well as investors and therefore a major contributing factor towards the increasing demand for apartments during this period.

Hence three main factors namely, the lack of local planning guidance due to incomplete Master Plan Package (DMDP 1995), the lack of environmental consideration in BCR 1996 and the socio-cultural transition towards western values and lifestyle can be considered responsible for the densification that occurred in the residential areas during this period.

c) *Development Perspective under Mohanogar Imarat Nirman Bidhimala (MINB) 2008*

The arbitrary requirements of the BCR 1996 rules mostly framed by non-professional bureaucrats were not thoroughly researched about developing a desired physical and climatic environment. Accompanied by a weak implementation process, such inconsiderate rules could neither control unplanned growth and violations nor give any direction towards the planned development of a burgeoning city. On the contrary, these set of regulations contributed in cultivating corruption, deteriorating the environment, enticing illegal construction, destroying neighborhood harmony, wasting space and resources, and endangering lives. Therefore the urge for an appropriate and modern rule was developing in the backdrop of some building accidents in the 1990s. The authority, though alarmed, could not overcome red tape and mindset to enact new rules and improve the enforcement procedures (Rahman, 2011). Meanwhile as a response to the increasing demand for housing and shelter the real estate business kept on flourishing with an increased number of apartment builders appearing in the market. The sector showed a tremendous boost during 2004-06 which indicates the intensity of market driven densification (REHAB, 2007). Therefore by the first half of the new millennium, the bulge of unguided building activity regulated only by BCR 1996 rules and carried out by the Market-led densification left the residential areas of Dhaka mostly packed with six storied multistoried buildings which brought widespread environmental consequences as well as urban crises.

Realizing the environmental hazards and increasingly declining livability of the residential areas the Capital Development Authority (RAJUK) once again tried to control the development through preparing a new set of Building Construction Rules (BCR) known as Mohanagar Imarat Nirman Bidhimala (MINB) with the aim of a greater interest, i.e., sustainability of the city rather than benefits of individual plot owners. After several reviews, the new Rule received gazette notification on 12 April 2006, which became mandatory for all concerned. However, this was not made operative until February 2007 while the BCR 1996 continued functioning. In the confusing situation with two parallel rules, vested quarters took advantage of the older bye-law supposed to be abandoned due to shortcomings mentioned above. Moreover, some of the provisions conflicted with those in the Bangladesh National Building Code (BNBC) that was made mandatory in November 2006. Thus two more essential revisions of MINB were adopted subsequently as the 2007 and 2008 Rules respectively. With the abolishment of previous height restriction MINB 2008 introduced the FAR which would determine the height of the building in relation to the road width and plot size. The rule is applicable to all the areas of the Metropolitan Dhaka irrespective of any density limit. Hence, MINB 2008 paved the way for vertical expansion which initiated the emerging trend of building high rise buildings more than six stories. So from 2008 onwards, a new generation of high-rise buildings both residential and commercial started invading the horizon of the residential areas of Dhaka.



Source: REHAB, 2012

Chart 1.3: Comparison between real estate and GDP Growth

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Though the national, urban and Dhaka population have been growing with declining rates, Dhaka metro went through an upward curve during the latter half of the last inter-census period of 2001-2011. There was a sharp increase in in-migration during this time after 2005 (BBS 2011). In the phase of 2006-08, due to the changed socio-political scenario all sectors of the economy, including real estate, showed declining trends during this time. Many novice realtors ceased doing business. After this situation ended, the economy took off again. People resumed investing, and the real estate sector experienced a boom during 2009-11. But this boost was unlike the previous one of 2004-06 and did not last long (REHAB, 2010). Despite the fluctuations, the real estate sector made significant progress during 2005-2010. In fact, the real estate renting and business services have expanded every year from 2001-2010 due to sustained macroeconomic stability. The Chart 1.3 shows the comparison between overall GDP (Gross Domestic Product) growth and growth of Real estate, renting and business services. This period witnessed an increase in the price of the properties which boomed the real estate profit. By 2010 more than 1500 companies were active in the real estate sector with 1081 of them registered with REHAB (Seraj, 2012). Apart from the corporate ones, there are also many other companies/individuals engaged in such development in smaller scale and selling apartments to friends and relatives only which is mostly an Old Dhaka based practice.

The land price increased in this period for a number of reasons. Government could not provide adequate infrastructure and facilities to the newly proposed sites of development in Dhaka due to the lack of financial support and visionary planning. Consequently, growth was concentrated in the existing residential areas. As the government had no control on the land market, the developers" led concentric nature of growth within the existing residential areas contributed to the price hike of land. Another potential reason responsible for the increase of land price is the land use conversion of residential plots to commercial use which was frequently taking place in the existing residential areas. There is sufficient evidence to support the linkage between land use regulation and housing affordability. Two recent Harvard University studies showed that land use conversion increased average housing prices between 1.3 and 4.7%, depending on the intensity of land use regulations in a county (Cho, Wu, and Boggess, 2003). The price of land increased in areas like Dhanmondi, Banani, Gulshan after independence due to the above mentioned factors. Despite low-level developers" activity in old Dhaka in the early 80s the land price of old Dhaka remained considerably high for its importance as a commercial hub which always played a significant role in the regional and national economy (Islam et al, 2007). The price of the apartments escalated as a result of the rise in land price and associated building products. The price hike continued up to 2011 with prices of TK 30000/ sqft in locations like Dhanmondi, Banani, and Gulshan. The per capita income has shown a rising trend since 2009, and it is higher than the trend in 2002. The growth rate of Real Estate, Renting and Business service sector has increased over the 2002-2010 period. However, compared to overall GDP growth, this sector expanded at a slower rate, which explains the downward trend in real estate as a percentage of overall GDP.



Source: Sheltech Survey, 2014

Chart 1.4: Land price trends of Dhaka

In the last four decades, private developers have delivered more than an estimate 100000 units of apartments to the nation with an average of 9000 units each year (Sheltech, 2011). According to Bangladesh Bureau of Statistics, the construction sector accounted for a record 9.1% of GDP (Gross Domestic Product) in fiscal year 2012/13. But as the development activity carried out by the private sector was by and large unguided, it contributed to uncontrolled densification of the residential areas leading to a host of environmental consequences. On the other hand, it escalated the land price which peaked in 2011 forming an asset bubble that had a direct impact on the apartment price. Again the crash of the stock market had repercussion on the housing market as the affordability of the people suffered severely. This financial crisis along with the political unrest in late 2013 dented the country"s economic outlook, leading to lower consumer and investor confidence. All these factors melt down the flourishing business of the real estate. More and more apartments remained vacant with real estate facing a bank loan of 4212 crores. Apart from the overall

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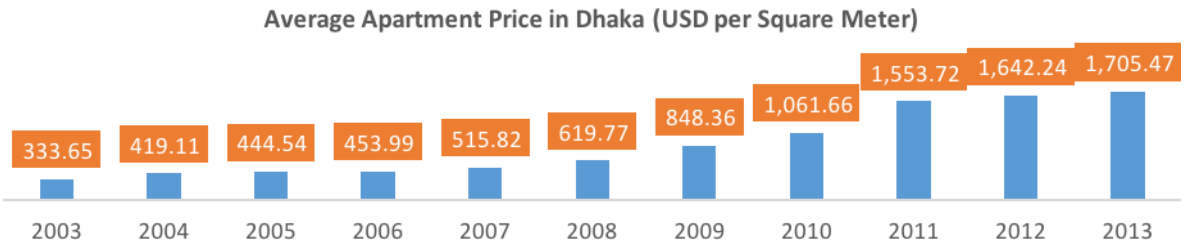
economic condition, the real estate companies could not get bank loans in a reasonable margin for real estate projects. As the asset bubble behaves in a symmetrical fashion in respect to time and price its reflection could be observed from the beginning of 2014 when the apartment prices started falling. To bounce back the real estate sector in business, the government declared that people who have undeclared money can now invest in property to legalize it.



Source: Sheltech Survey, 2014

Chart 1.5: Upward trend of apartment prices in Dhaka (2003 - 2013)

Despite the political unrest that occurred in late 2013, Bangladesh emerged as the second favored investment destination in South Asia after India. The US Government"s 2013 investment climate statement for Bangladesh notes that the country presents promising business opportunities because it offers a "highly competitive labor force, an entrepreneurial business community and a resilient and steadily growing economy." The country was found different in projecting 7 percent growth for the FYP 2016 even with the lowest fiscal capacity. 2014 was an interesting time for real estate market. A renewed consumer interest seemed stemming as a lot of people tried to take advantage of the low price property market situation and made more purchases than the preceding year. The country"s economic development and rising standard of living was the key drivers of this change, according to property agents surveyed by Lamudi Real Estate online service. Top three chief influences on the investment environment were 71% economic development, 36% rising standard of living and 32% infrastructure development. In the property market, while apartment remains the most commonly searched estate, there was an overall growth in search for all properties across the year of 2014.

In 2015, Bangladesh became the 4th fastest growing economy in South Asia, down one position compared to 2014 due to political uncertainty and unfriendly business policies. The growth of customer pessimism had strengthened where Dhaka had 20,000 apartments ready for sale, compared to 13,000 unsold ones in 2013-14. Developers have been forced to reduce prices by 11 percent and land prices by 14.2 percent to entice customers. In contrast to only 17% rent requests for rent in 2014, the figures drastically became a 60-40 split between buying and renting in 2015 in the real estate market. Even though apartments are 26.92% cheaper than their peak in 2012 Dhaka remains the most expensive place to buy or rent property across the country. Though the demand for housing prevails, the bulk of unsold apartments of the real estate developers indicate that these luxurious high rise buildings are not built to address the overall shortage but to serve their ends which is profit maximization. This implies that the densification of the existing residential areas that gained momentum from the 90s was basically a market- led densification rather than a demand led. Since motivation behind the private sector"s housing is profit maximization they are the least concerned about the negative impacts which the unguided densification exerts on neighborhood livability and sustainability of the city as a whole. Though the contribution of real estate developers in the supply of housing is quite significant this is accounts for just 30% of the urban population comprising of the well-off class. The vast majority of the urban population belonging to low- income class still cannot afford a decent home and environment for living. Clearly, a political intervention has been long overdue to strike a balance between the two ends to serve the public interest. However, government had already taken some steps to rectify the situation by unlocking the liquidity in the banks formed by the asset bubble. The real estate sector is in a very precarious position in the current year (2016) given the difficult period it went through the year before. The pace of slow and steady growth hampered by the political unrest of January 2016, significantly slowed down the whole economic engine of the nation.

The government in a measure to boost sales had halved VAT on small flats by 1.5% making them more affordable to middle-income families and on large size apartments increased by 50% to 4.5%. Additionally, there has been an increase in the Housing loan ceiling from Tk. 10 million to Tk. 12 million to support customers against rising construction costs. To decongest the residential areas the government has also taken an

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initiative to evict all the illegal commercial setups from the existing residential settlements. Though the eviction strategy is subjected to controversy and requires more insight but the effort is praise worthy. All these measures seem to have positive effects on people"s growing confidence and interest in buying apartments which were reflected on the leading real estate online portal of Lamudi website thorough a increase in the percentage of property searchers in 2016 than in May 2016. According to Lamudi on-site data the most searched site is Mirpur, Dhaka, 29% of the property seekers are finding house in Mirpur area in 2016. Uttara is standing in second position as 25% of property hunters are searching property in this area which is due to the better connectivity and reasonably affordable property price and rental structure of these two areas. The scenario was almost similar for first two places in 2014, where Mirpur and Uttara were in first and second place consecutively. With technological advancement through internet availability and government intervention as regulator, the real estate sector can be utilized in developing residential areas to the benefit of both customers and developers.

III. Conclusion

The above discussion has presented an insight into the socio-economic and political factors working as the driving forces in the development and densification of residential areas of Dhaka. Together it has also pointed out the potential of the population window which if harnessed through thoughtful densification strategy can bring economic prosperity and sustainability of the city as well as the country itself.

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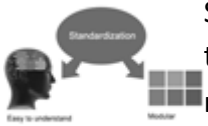

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4. Manuscript's Category,

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26. Go for seminars: Attend seminars if the topic is relevant to your research area. Utilize all your resources.



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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.

30. Think and then print: When you will go to print your paper, notice that tables are not be split, headings are not detached from their descriptions, and page sequence is maintained.

31. Adding unnecessary information: Do not add unnecessary information, like, I have used MS Excel to draw graph. Do not add irrelevant and inappropriate material. These all will create superfluous. Foreign terminology and phrases are not apropos. One should NEVER take a broad view. Analogy in script is like feathers on a snake. Not at all use a large word when a very small one would be sufficient. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Amplification is a billion times of inferior quality than sarcasm.

32. Never oversimplify everything: To add material in your research paper, never go for oversimplification. This will definitely irritate the evaluator. Be more or less specific. Also too, by no means, ever use rhythmic redundancies. Contractions aren't essential and shouldn't be there used. Comparisons are as terrible as clichés. Give up ampersands and abbreviations, and so on. Remove commas, that are, not necessary. Parenthetical words however should be together with this in commas. Understatement is all the time the complete best way to put onward earth-shaking thoughts. Give a detailed literary review.

33. Report concluded results: Use concluded results. From raw data, filter the results and then conclude your studies based on measurements and observations taken. Significant figures and appropriate number of decimal places should be used. Parenthetical remarks are prohibitive. Proofread carefully at final stage. In the end give outline to your arguments. Spot out perspectives of further study of this subject. Justify your conclusion by at the bottom of them with sufficient justifications and examples.

34. After conclusion: Once you have concluded your research, the next most important step is to present your findings. Presentation is extremely important as it is the definite medium though which your research is going to be in print to the rest of the crowd. Care should be taken to categorize your thoughts well and present them in a logical and neat manner. A good quality research paper format is essential because it serves to highlight your research paper and bring to light all necessary aspects in your research.

Informal Guidelines of Research Paper Writing

Key points to remember:

- Submit all work in its final form.
- Write your paper in the form, which is presented in the guidelines using the template.
- Please note the criterion for grading the final paper by peer-reviewers.

Final Points:

A purpose of organizing a research paper is to let people to interpret your effort selectively. The journal requires the following sections, submitted in the order listed, each section to start on a new page.

The introduction will be compiled from reference matter and will reflect the design processes or outline of basis that direct you to make study. As you will carry out the process of study, the method and process section will be constructed as like that. The result segment will show related statistics in nearly sequential order and will direct the reviewers next to the similar intellectual paths throughout the data that you took to carry out your study. The discussion section will provide understanding of the data and projections as to the implication of the results. The use of good quality references all through the paper will give the effort trustworthiness by representing an alertness of prior workings.

Writing a research paper is not an easy job no matter how trouble-free the actual research or concept. Practice, excellent preparation, and controlled record keeping are the only means to make straightforward the progression.

General style:

Specific editorial column necessities for compliance of a manuscript will always take over from directions in these general guidelines.

To make a paper clear

· Adhere to recommended page limits

Mistakes to evade

- Insertion a title at the foot of a page with the subsequent text on the next page
- Separating a table/chart or figure - impound each figure/table to a single page
- Submitting a manuscript with pages out of sequence

In every sections of your document

· Use standard writing style including articles ("a", "the," etc.)

· Keep on paying attention on the research topic of the paper

· Use paragraphs to split each significant point (excluding for the abstract)

· Align the primary line of each section

· Present your points in sound order

· Use present tense to report well accepted

· Use past tense to describe specific results

· Shun familiar wording, don't address the reviewer directly, and don't use slang, slang language, or superlatives

· Shun use of extra pictures - include only those figures essential to presenting results

Title Page:

Choose a revealing title. It should be short. It should not have non-standard acronyms or abbreviations. It should not exceed two printed lines. It should include the name(s) and address (es) of all authors.



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Abstract:

The summary should be two hundred words or less. It should briefly and clearly explain the key findings reported in the manuscript--must have precise statistics. It should not have abnormal acronyms or abbreviations. It should be logical in itself. Shun citing references at this point.

An abstract is a brief distinct paragraph summary of finished work or work in development. In a minute or less a reviewer can be taught the foundation behind the study, common approach to the problem, relevant results, and significant conclusions or new questions.

Write your summary when your paper is completed because how can you write the summary of anything which is not yet written? Wealth of terminology is very essential in abstract. Yet, use comprehensive sentences and do not let go readability for briefness. You can maintain it succinct by phrasing sentences so that they provide more than lone rationale. The author can at this moment go straight to shortening the outcome. Sum up the study, with the subsequent elements in any summary. Try to maintain the initial two items to no more than one ruling each.

- Reason of the study - theory, overall issue, purpose
- Fundamental goal
- To the point depiction of the research
- Consequences, including definite statistics - if the consequences are quantitative in nature, account quantitative data; results of any numerical analysis should be reported
- Significant conclusions or questions that track from the research(es)

Approach:

- Single section, and succinct
- As a outline of job done, it is always written in past tense
- A conceptual should situate on its own, and not submit to any other part of the paper such as a form or table
- Center on shortening results - bound background information to a verdict or two, if completely necessary
- What you account in an conceptual must be regular with what you reported in the manuscript
- 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

Introduction:

The **Introduction** should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable to comprehend and calculate the purpose of your study without having to submit to other works. The basis for the study should be offered. Give most important references but shun difficult to make a comprehensive appraisal of the topic. In the introduction, describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will have no attention in your result. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here. Following approach can create a valuable beginning:

- 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:

- Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done.
- Sort out your thoughts; manufacture one key point with every section. If you make the four points listed above, you will need a least of four paragraphs.

- Present surroundings information only as desirable in order hold up a situation. The reviewer does not desire to read the whole thing you know about a topic.
- Shape the theory/purpose specifically - do not take a broad view.
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Procedures (Methods and Materials):

This part is supposed to be the easiest to carve if you have good skills. A sound written Procedures segment allows a capable scientist to replacement your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt for the least amount of information that would permit another capable scientist to spare your outcome but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section. When a technique is used that has been well described in another object, mention the specific item describing a way but draw the basic principle while stating the situation. The purpose is to text all particular resources and broad procedures, so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step by step report of the whole thing you did, nor is a methods section a set of orders.

Materials:

- Explain materials individually only if the study is so complex that it saves liberty this way.
- Embrace particular materials, and any tools or provisions that are not frequently found in laboratories.
- Do not take in frequently found.
- If use of a definite type of tools.
- Materials may be reported in a part section or else they may be recognized along with your measures.

Methods:

- Report the method (not particulars of each process that engaged the same methodology)
- Describe the method entirely
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures
- Simplify - details how procedures were completed not how they were exclusively performed on a particular day.
- If well known procedures were used, account the procedure by name, possibly with reference, and that's all.

Approach:

- It is embarrassed or not possible to use vigorous voice when documenting methods with no using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result when script up the methods most authors use third person passive voice.
- Use standard style in this and in every other part of the paper - avoid familiar lists, and use full sentences.

What to keep away from

- Resources and methods are not a set of information.
- Skip all descriptive information and surroundings - save it for the argument.
- Leave out information that is immaterial to a third party.

Results:

The principle of a results segment is to present and demonstrate your conclusion. Create this part a entirely objective details of the outcome, and save all understanding for the discussion.

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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Content

- Sum up your conclusion in text and demonstrate them, if suitable, with figures and tables.
- In manuscript, explain each of your consequences, point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation an exacting study.
- Explain results of control experiments and comprise remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or in manuscript form.

What to stay away from

- Do not discuss or infer your outcome, report surroundings information, or try to explain anything.
- Not at all, take in raw data or intermediate calculations in a research manuscript.
- Do not present the similar data more than once.
- Manuscript should complement any figures or tables, not duplicate the identical information.
- Never confuse figures with tables - there is a difference.

Approach

- As forever, use past tense when you submit to your results, and put the whole thing in a reasonable order.
- Put figures and tables, appropriately numbered, in order at the end of the report
- If you desire, you may place your figures and tables properly within the text of your results part.

Figures and tables

- If you put figures and tables at the end of the details, make certain that they are visibly distinguished from any attach appendix materials, such as raw facts
- Despite of position, each figure must be numbered one after the other and complete with subtitle
- In spite of position, each table must be titled, numbered one after the other and complete with heading
- All figure and table must be adequately complete that it could situate on its own, divide from text

Discussion:

The Discussion is expected the trickiest segment to write and describe. A lot of papers submitted for journal are discarded based on problems with the Discussion. There is no head of state for how long a argument should be. Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implication of the study. The purpose here is to offer an understanding of your results and hold up for all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of result should be visibly described. Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved with prospect, and let it drop at that.

- Make a decision if each premise is supported, discarded, or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."
- Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work
- You may propose future guidelines, such as how the experiment might be personalized to accomplish a new idea.
- Give details all of your remarks as much as possible, focus on mechanisms.
- Make a decision if the tentative design sufficiently addressed the theory, and whether or not it was correctly restricted.
- 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?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

- When you refer to information, differentiate data generated by your own studies from available information
- Submit to work done by specific persons (including you) in past tense.
- Submit to generally acknowledged facts and main beliefs in present tense.

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- Do not give permission to anyone else to "PROOFREAD" your manuscript.

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Topics	Grades		
	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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