проницаемых породах, но как в том, так и другом случаях существует предельная глубина рудообразования.

Заключение

Результаты обобщения геолого-геофизических материалов по Дегтярско-Полевской площади позволяют судить о разной геологической ситуации для месторождений Зюзельское, Дегтярское, Чусовское, что подтверждается материалами геофизических работ.

Изучение природы горных пород, особенно серпентинитов, образованных по карбонатным породам, позволяет судить о возможно более глубоких горизонтах рудообразования для Дегтярско-Чусовской полосы (300-500 м) относительно Зюзельской (до 300 м), может привести и к дальнейшему изучению геологической природы Среднего Урала, и к новым открытиям рудных проявлений медного колчедана.

Установленная закономерность уменьшения сопротивления при приближении к рудному телу позволяет установить границы гидротермально измененных пород, в которых возможно обнаружение рудного тела.

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МНОГОКРИТЕРИАЛЬНЫЕ МЕТОДЫ ПОДДЕРЖКИ ПРИНЯТИЯ РЕШЕНИЙ В ЛЕСНОМ ХОЗЯЙСТВЕ: ОБОСНОВАНИЕ ВЫБОРА СПОСОБА ЛЕСОРАЗВЕДЕНИЯ (MUCLTICRITERIA FOREST DECISION-MAKING: FORESTATION METHODS)

Human activity has violated three planetary boundaries out of nine ones identified by J. Rockström [1]. As never before, humanity fundamentally depends on forest ecosystems, their structure and services they provide. Therefore forest scientists and decision-makers should be especially careful and sensitive in their recommendations to forest owners concerning activities with long-term impacts. Increasing role of forest and forest ecosystems services in sustaining global environment and enjoying from human wellbeing becomes an undeniable fact.

Under these vulnerable conditions a great interest in forest decision-making is paid to forestation methods. This is especially acute today in rapidly changing climate conditions. A wisdom choice of a proper forestation method for a new forest stands establishment, both naturally or artificially, on an area, whether previously forested or not, is a crucial task of forest policy in present conditions of climate model change.

Traditional forest planning is based on principles of constancy and long-term stability. Silvicultural programmes were assumed to remain constant for at least for one rotation. In modern reality, however, periodic reorientation and frequent changes of forest policy are quite common. The duration of forest policy changes becomes much shorter than the life span of the trees. And only a *'design window'* [2] remains open and challenging for forest decision-making particularly in forestation in condition of fuzziness and uncertainty where stakes are high and time is pressing.

In conditions of West Ukraine plains there are three forestation methods usually applied in local silviculture practice: natural reforestation, artificial forestation and fast-growing plantations. Each of them has own advantages and disadvantages and cautions for use, resulting from the forest site, forest type, particular species, targets of forest operations, forest policy etc. To compare forestation alternatives we used four criteria: silviculture, ecological, economic and social following sustainable forest management mainstream.

Solving problem of forestation policy optimization we applied Analytic Hierarchy Process (AHP), which allows pairwise comparison of alternatives and criteria for making the best choice between competing solutions following several objectives / criteria [3, 4]. Basically AHP is a general theory of measurement based on some mathematical and psychological principles. In the method, a hierarchical decision schema is constructed by decomposing the decision problem in question into decision elements – goals, objectives/criteria, attributes and decision alternatives. The general goal is at the top of a decision hierarchy, and decision alternatives constitute the lowest level.

We developed a multicriteria optimization hierarchy (Fig. 1) to choose the best forestation method taking into consideration four abovementioned criteria: silvicultural, environmental, economic and social to compare three alternatives: natural reforestation, artificial reforestation and fast-growing plantation.

The silviculture criterion involves: Time for forest site recover; Resilience of forest; Rotation age; Phytomass productivity on a site. Environmental criterion involves: Conservation of forest flora and fauna; Forest ecosystem services except carbon sequestering; Carbon sequestration; Eco-destructive impacts. To make the comparison more transparent we decided to separate a carbon sequestering from the rest of forest ecosystem services because in case of forest plantation a high level of sequestration does not mean a high level of other forest ecosystem services. Economic criterion deals with Forest stands productivity; Cost of forestation; Economic efficiency; Output of industrial wood. Social criterion covers New jobs for local population; Provision of forest goods; Forest services; Land use changes.

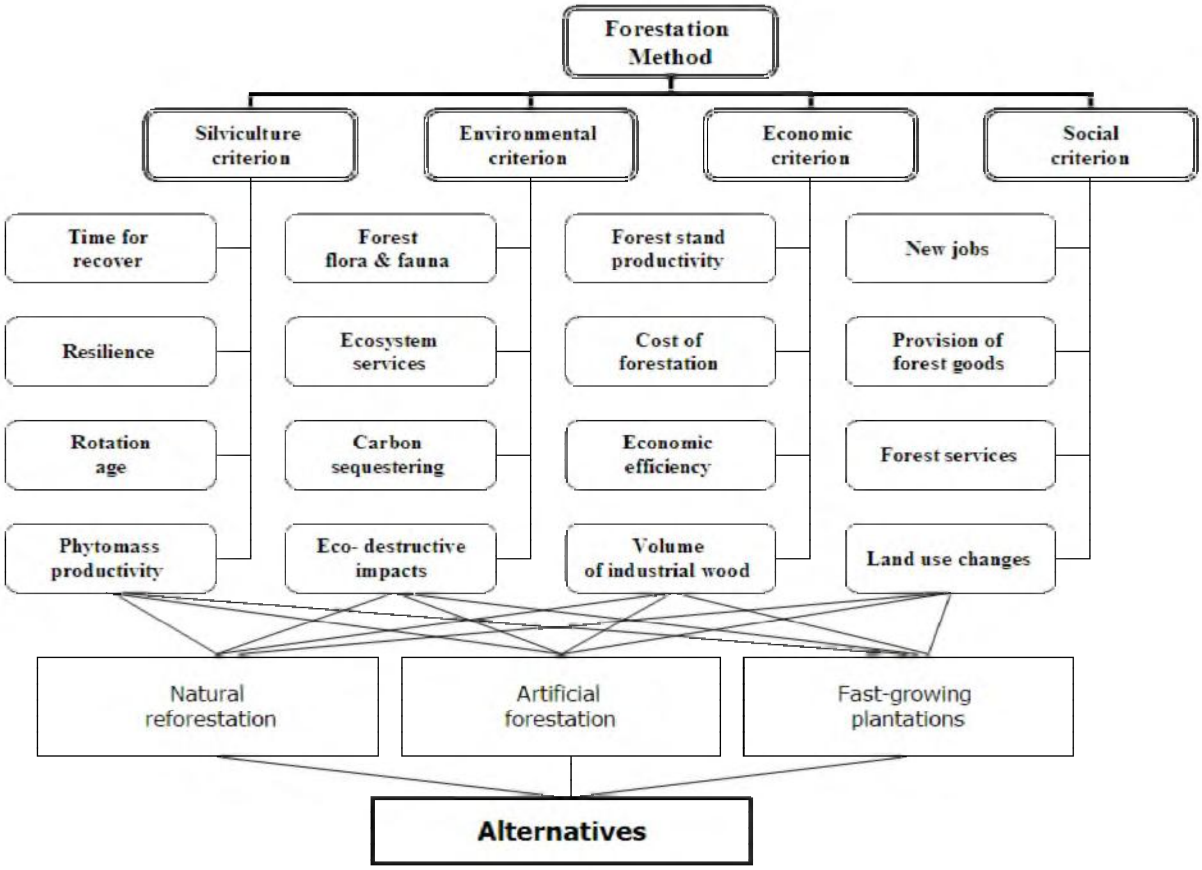

Fig. 1. Problem hierarchy: selection of forestation method

To examine the best forestation method to be used under specific silviculture / environment / economic / social conditions for multicriteria assessment of forestation methods under conditions of a local forest enterprise we applied Expert Choice Software. Pairwise comparison both forestation alternatives and evaluation criteria was based on experts' discourse and evaluations of the objects in question.

To verify consistency of experts' comparative judgments we calculated an inconsistency ratio, a measure of experts' answers inconsistency. As it comes from theory, an inconsistency ratio should be lower than 0.1. In our case it was equal to 0.06 so that consistency of experts' evaluations was proved.

Our experts set such weights for evaluation criteria: environmental – 0.609, economic – 0.201, social – 0.121, and silvicultural – 0.069 (Fig. 2). In this case the best alternative is a natural reforestation, it got 61.9%. Fast-growing plantations alternative is a quite far behind it –21.4% and artificial forestation has the smallest attractiveness 16.6%. Sensitivity analy-sis demonstrates that in the case of an increase of economic criterion weight up to 0.68 the most preferable becomes a fast-growing plantations alternative, that most of all contradicts to sustainable forest management.

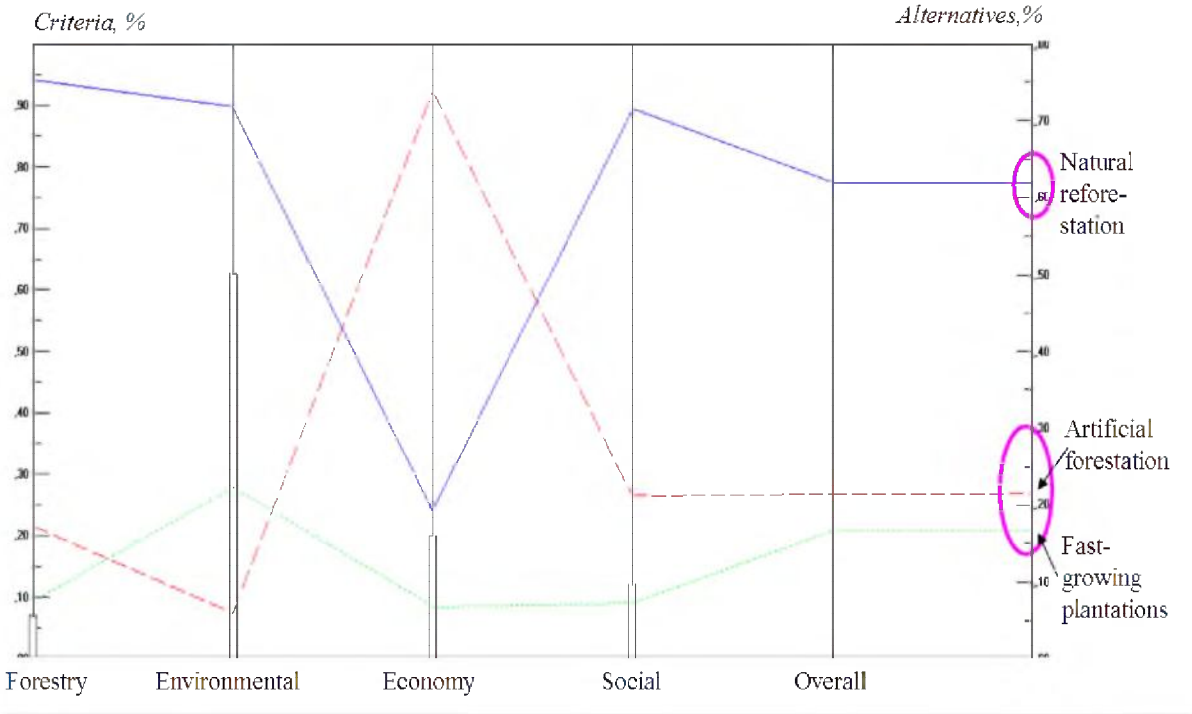

Fig. 2. Ranking forestation alternatives by four criteria

However, giving in sensitivity analysis the highest degree of importance to economic criteria (0.68 and more), we can see that fast-growing plantations becomes the best alternative, its score equals to 46%, natural reforestation got the second position and 43% and artificial forestation has the third one (11%).
These results explicitly show politicians / decision-makers / scholars how setting priorities of forest and environmental policy can easily drive forestry (as any other human activity) in (non) sustainable way. This model could be used by policy makers and for education purposes to simulate different scenarios of forest policy. It can be used to give a society a message about role of goals in decision making in conditions of an existing quadruple squeeze [5] to sustainability.

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ОЦЕНКА УСТОЙЧИВОСТИ РАЗВИТИЯ ЛЕСНЫХ ЭКОСИСТЕМ (FOREST ECOSYSTEM DEVELOPMENT STABILITY EVALUTION)

Истощение природных ресурсов неоднократно вызывало региональные кризисы, влияя на экономическое благополучие. В связи с этим объективная оценка устойчивости экологических систем – центральная проблема в рамках концепции устойчивого развития регионов. Несмотря на множество публикаций по этой теме, проблема оценки устойчивости природных систем по-прежнему остро актуальна.

Цель нашей работы – разработка на основе теоретических положений генетической типологии Б.П. Колесникова и теории катастроф Р. Тома междисциплинарного подхода для оценки устойчивости восстановительно-возрастной динамики лесной растительности после сплошных рубок.

Исследования проводились в южно-таежном округе Зауральской холмисто-предгорной провинции [1] между 57°00′–57°05′ с.ш. и 60°15′–60°25′ в.д. К настоящему времени, несмотря на сильную нарушенность растительности в районе исследований, найдены участки старовозрастных (140–200-летних) условно-коренных лесов во всех основных типах лесораститель-