A misfit in policy to protect Russia’s black soil region. An institutional analytical lens applied to the ban on burning of crop residues

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ABSTRACT

Russia’s region of Chernozem and Kastanozem soils in Western Siberia, where this study focused on the Kulunda steppe, has great potential as a carbon sink, particularly if the current widespread practice of burning crop residues can be replaced with conservation tillage practices that will return the residue to the soil. Environmentally-oriented land use policy measures have been introduced that could accomplish that goal. But these measures are quite recent, and face obstacles in the prevailing post-socialist institutional environment and in cultural norms.

This paper explores factors influencing implementation effectiveness of policies that support prevention of soil erosion and nutrient loss. We refer to Williamson’s four levels of social analysis, and thereby add to it a dynamic component, illuminating the timeframe required for changing the criteria under investigation. A case study in the Kulunda steppe (Altai krai) with 24 semi-structured interviews revealed that critical factors affecting soil protection policy implementation exist at all levels of social interaction.

We use one example of a Russian regulatory measure – the ban on crop residue burning – to explore and systematize critical socio-economic, administrative and institutional factors that diminish the impact of such a command-and-control regulation. Credible monitoring and sanctioning to implement the ban turned out to be almost impossible. Farmers’ beliefs about the positive effects of burning on the soil could not be changed by short-term administrative regulations, and there are no alternative off-field uses for the residue. This empirical study shows that information provision and subsidies for voluntary conservation tillage practices are likely to be more effective measures to counter soil degradation than the residue-burning ban.

1. Introduction

In the Siberian steppe, in the context of the Virgin Land Campaign during the Khrushchev era in the 1960s, 6.2 million hectares grassland were earmarked for ploughing (Illiger et al., 2014). In the Altai krai of South-Western Siberia 2.3 million ha natural steppes were largely transformed into arable land (Durgin, 1962). Its size alone made the whole campaign one of the biggest human-designed land use changes in the world. Land use change from grassland to cropland involves a loss of organic carbon due to smaller residue inputs into the soil plus larger soil organic matter decomposition due to tillage operations (Bischoff et al., 2016).

Our study has been conducted in the Kulunda steppe in the Altai krai. Today, this steppe is largely used for farming, and crop residue burning is widespread (Romanenkov et al., 2014). In line with a number of studies that dig into the bio-physical effects of burning on soils (such as Fernández et al., 2016; Wang et al., 2016), Novara et al. (2011) regard fire as the main contributor to land degradation. Crop residue burning also increases atmospheric pollution because of additional emission of greenhouse gases (Huang et al., 2012; Smil, 1999). A regional NGO, the Gebler Ecological Society, which is one of environmental organizations actively involved in the soil protection and anti-burning campaign in Altai krai, points to serious ecological risks that agricultural fires pose for the steppe’s fauna. The Gebler organization also cites serious damage to village infrastructures from uncontrolled field fires.

We will show that, in the Russian context, farmers have almost no off-field uses for crop residues. Thus, if they do not burn it, they have to switch to conservation tillage practices. Conservation tillage is defined as a tillage system that leaves enough crop residues (at least 30%) in the field after harvest to protect the soil from erosion (Uri, 1999). Conservation tillage likewise serves the goals of carbon sequestration and

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soil humus accumulation (Frühaufl and Meinel, 2006). It has capacity to reduce severe wind erosion and soil degradation (Lafîen et al., 1985; Smil, 1999), both of which are seen as a continuous risk for the Kulunda region (ROSREESTR, 2013). How to facilitate conservation tillage politically – and what local socio-economic and institutional factors caused the ineffectiveness of current soil protection policies – are the questions this paper pursues. We will analyze this with a systematic policy analysis based on the Procedure for Institutional Compatibility Assessment, which focuses on the congruency of formal rules with the prevailing institutional environment. In order to make predictions on the effectiveness of a formal measure, we apply the analytical framework of Williamson’s level of social analysis, highlighting different time spans needed to change various formal and informal institutions that should ideally support one another.

There are a number of studies that analyze factors that foster compliance with soil conservation regulation mostly based on economic reasoning. Prager and Posthumus (2010) list belief in positive effect on soil fertility and higher yields, decreased costs, confidence in state-governed programs and authorities, knowledge and awareness of state programs, and flexibility of prescriptions as important in the adoption of conservation tillage practices. As a consequence of the US dust bowl in the 1930s, there are early studies such as the one from Uri (1999) that point out that the factors that impact adoption of conservation technologies are difficult to quantify. Uri (1999) emphasizes farmers’ profitability considerations: basically, farmers’ perception of a gain in net benefits from switching technologies. The benefit consideration involves not only direct income gains but also adjustment costs such as having to learn new production skills (Uri, 1999). In addition to the many scholars who deal with economic aspects, others such as Schneider et al. (2010) focus on the importance of values and the symbolic meaning of adopting soil conservation practices. Recently, Pereira et al. (2016) show that farmers’ perception of the environmental consequences of their actions also has major impact on how they engage with conservation practices and thus, whether and how they follow the relevant legal regulations. Wossink and van Wenum (2003) found that the production environment and familiarity with conservation programs better explained participation in conservation programs than farm characteristics, such as farm size or lack of a successor. Farmers’ personal characteristics such as innovativeness could not be proven as decisive for actual participation in conservation practices.

For post-socialist countries, including Russia, Prishchepon et al. (2012) highlight the importance of institutions — mainly differences in land privatization strategies and land markets — in farmers’ land use decisions. Studies on the institutional environment of soil protection policies in countries with a comparable post-socialist legacy show a mix of personal, socio-cultural and economic, along with institutional and political, factors that influence behavior in soil conservation efforts (Prager and Posthumus, 2010; Stupak, 2016) and that limit the effectiveness of existing laws (Prager et al., 2011; Prager et al., 2012).

In the Ukraine, for instance, mainly institutional and political factors influence behavior in soil conservation efforts (Stupak, 2016). After destruction of the elaborated soil protection system set up in Soviet times, the authorities did not manage to develop either new sets of sound soil protection rules, or mechanisms to enforce these. In addition, soil monitoring of agricultural land for example, still does not collect information on the rates of wind and water erosion (Stupak, 2016). Another factor typical for post-socialist countries is unclear property rights and duties. Stupak (2016) identifies this for the shelterbelts, which lost their function of soil protection because the task of managing them were not assigned to any actor.

Prager et al. (2012) have shown, for Bulgaria, Czech Republic and the former German Democratic Republic, how farmers’ environmental awareness and understanding of relevant soil conservation policies, the perceived trustworthiness of authorities, and limited accessibility of advisory systems are all factors that influence farmer behavior in soil conservation efforts. Likewise, land-use rights and the connection between landowners and farmer-lessors play a role. Prager et al. (2012) particularly highlight the problem of incoherent policy frameworks for soil conservation, exemplified by overlapping and partly contradictory soil conservation measures, which are neither targeted to a soil specific degradation type nor provided with appropriate enforcement mechanisms, limiting the effectiveness of existing laws. Another social factor is peer pressure, when fields are perceived to look messy under conservation tillage (Prager et al., 2012).

In general, institutions – both formal and informal – play a significant role in supporting land use changes towards better environmental quality. Russia largely follows a formal command-and-control policy approach. The Kulunda example of a recent policy measure that simply, and quite ineffectively, banned the burning of crop residue on agricultural and forest land demonstrates how such an approach creates a misfit between the policy and the prevailing social and institutional context. The crucial factors that facilitated or hampered the implementation of this measure can inform assessment of efficacy and cost-efficiency of any similar proposed command-and-control policy measures and thus provide policy guidance. Such an analysis can further stimulate policy-makers and regional administrators to initiate extensive evaluation of future measures, a strategy still rather seldom undertaken in the Russian context.

The paper is organized as follows. Chapter 2 introduces the case study area, outlines the extent of burning of crop residues in Russia and presents the promulgation of the policy aiming to ban it. Further, Chapter 2 elaborates on the analytical framework and theoretical concepts employed, and finally describes the data collection. Chapter 3 presents the results, the empirically-based ranking of institutional aspects leading to ineffective policy implementation, and an ordering and discussion of these crucial institutional aspects according to Williamson’s level of social analysis. In the discussion and conclusion, Chapter 4, selected aspects such as deeply rooted beliefs about the presumed advantage of residue burning – beliefs which take very long to change requiring considerable advisory work and educational reforms – are contrasted to aspects such as adjustment costs of farmers which can easily be addressed in the short-term with compensation measures.

2. Methods and conceptual framework

2.1. The Kulunda steppe in Altai Krai

The Altai krai, which represents an administrative unit in the Russian Federation, covers some 16.8 mio hectare, of which 11.6 mio hectare are classified as agricultural land (56% arable land and 32% pastures) (ROSREESTR, 2013). The study area – the semi-arid Kulunda steppe in Altai krai (see Fig. 1) – stretches over an area of approximately 8.6 million hectares, with 6.7 million hectares agricultural land (ROSREESTR, 2013). Cultivation in the Kulunda region began in 19th century, but in the 1950’s and 1960’s – in line with the Soviet production-oriented policy – ploughing of the steppe land and massive cash crop cultivation was initiated, in what was known as the Virgin Land Campaign (Durgin, 1962). Notably, in the development history of the Kulunda region in Soviet times and after (collectivization, village resettlement, production orientation), all change has been implemented by regulatory policy instruments (Wegner, 2013).

Since 1991, the Altai krai has followed the federal privatization reforms. Land and asset shares of former collectives (kokhozes) and state farms (sovkhozes), have been redistributed initially in ideal shares to eligible persons. During the early years of reform, local authorities tried to keep individuals from withdrawing their newly-distributed share of the collective property. Therefore, all through the 1990s, agricultural

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3 Ideal land shares mean there are no recognized boarders yet, where your actual plot of land is.
land largely continued to be managed by successors of collective and state farms (Shagaida and Lerman, 2017). The land market in Russia was highly regulated since the beginning of the reform. Partial liberalization of the land market took place already with the Land Code in 2001, which allowed land sales with formal ownership titles. The transfer of ideal shares into registered land ownership titles, however, involved high transaction costs, such as the required detailed surveys of land plots and preparation of official cadastral documents. Further, preemptive rights and specific bans are imposed on some land transactions (Shagaida, 2014). Despite high transaction costs, land is slowly but steadily being redistributed between different groups of users and land-leasing transactions are nowadays widespread, demonstrating the development of a land market (Shagaida and Lerman, 2017). Yet the former agricultural enterprises have been only slowly restructured into a range of privately held corporations’ farms. In this, the land market in Altai krai followed the development in the whole of Russia. Statistics on the land ownership structure in 2013 showed still about 42% of the Krai’s agricultural land is defined as under state ownership (ROSREESTR, 2013).

Overall, Russia experienced a dramatic change in farm structure: In 1990 the kokhozes and sovkhozes nationwide dominated agriculture by controlling 97% of agricultural land. By 2013, the share of the successors of collective and state farms had dropped to 63%, while the share of the individual sector (household plots and peasant farms that began to be created in 1992) had increased to 37%. Agricultural statistics show the following distribution of used land to four groups of farms in 2013: the largest category of producers – the successor of the collective and state farms (the private corporations) control 57% of all agricultural land. The household plots, not officially registered as a legal entity, nonetheless control 25% of all agricultural land. Peasant farmers increased their holdings from zero in 1990–12% in 2013, while state and municipal farms controlled less than 5% of agricultural land (ROSREESTR, 2013). As pointed out by Shagaida and Lerman (2017) agricultural land controlled by farms does not necessarily mean cultivated by farms, because even in regions with favorable agro-climatic conditions land is often underutilized.

In the Altai krai, similar characteristics of user groups are responsible for production decisions, driving the observable land use. Private corporate farms, mostly the successors of former collectives, cultivate half of the agricultural area. Statistics on Altai krai show that the other groups, the peasant and semi subsistence farms cultivate around 3.7 million hectares, of which the subsistence household plots occupy around 250,000 ha. In total, the Altai krai counts 676,000 agricultural companies and (semi)subsistence household units (ROSREESTR, 2013).

The growing season lasts only 110–130 days. Precipitation imposes limits on agricultural production, varying between 180 mm in the dry steppe to 450 mm in the forest steppe zone of the Kulunda steppe (Tatarincev et al., 2010). The main crops grown are spring and winter wheat with some rotation of oil seeds and legumes, mainly peas.

Western Siberia is a region of global importance due to the massive amounts of carbon stored in the soils (Degefi et al., 2014). The soils are classified among those of cool-tempered grasslands. Due to their physical and chemical characteristics these soils are Chernozems and Kastanozems with high agronomic potential. Regional spatial patterns show that the Kulunda area will become drier and warmer, with increased drought risk leading to increased risk of fire intensity (Degefi et al., 2014). That would lead to a release of enormous amounts of stored carbon into the atmosphere.

Official figures confirm that 75% of agricultural soils in the Kulunda region are to some extent environmentally degraded (Illiger et al., 2014; ROSREESTR, 2013). The original humus content before cultivation has been estimated on average being 9.6% in the forest steppe zone. Data show large variances between regions and plots, but continuous reduction of soil organic content (Charlamova and Revyakin, 2006). Humus content has dropped severely to below 2% in some
regions (Belajev, 2009). Recent studies by Bischoff et al. (2016) investigated the impact of land use change on organic content in Siberian steppe soils. They predict a pronounced organic matter loss in a drying climate if accompanied by land use change towards cropland.2

2.1.2. Policy measure investigated
Although crop residue harvests represent most of the world’s phyto-mass annually, little attention has been paid to it, including the “malpractice” of burning it (Smil, 1999). Data obtained from advanced satellite remote sensing methods indicate that for the 2001–2003 period 31–36% of all agricultural fires worldwide occurred in Russia, making that country globally the largest contributor to agricultural crop residue burning (CRB) (Koronitz et al., 2006). The practice was applied for centuries over the whole Kulunda region, long before cultivated agriculture was introduced, as a way of stimulating growth of grass for grazing. Sukhinin et al. (2004) have calculated from satellite pictures that in 2000 an area of 164,000 ha was burned in Altai krai. Using figures from Russia’s Federal Forest Agency, the agricultural land area under fire accounted for 76,000 ha in Altai krai in the first half of 2014 encompassing arable land as well as dry grasslands (Federal Forest Agency, 2016).3,4 For all of Russia, Rusakova (2009) calculated that by burning the straw, 20–25 million tons of carbon and 250,000 tons of nitrogen are lost annually; meanwhile, only 5–7% of the arable land receives organic fertilizers. Despite the known side-effects, burning allows a relatively easy way of disposing of residue from arable land and preparing the land for subsequent agro-technological operations with standard Soviet-era technology. Notably, off-field demand for crop residues (Smil, 1999), such as for animal husbandry, is very limited in contemporary Russia (Romanenkov et al., 2014, p.349). The average density of cattle is only around 7 head/100 ha of agricultural land (ROSSTAT, 2016). Thus, the chief alternative to burning residues is mulching them.

The positive effect of residue mulching is widely recognized in agronomy. Mulching means the previous crop’s harvest is managed so that the residue complements the seeding and crop production process. Residue can then become a valuable asset in increasing overall production. The results of such a conservation tillage practice are that standing stubble and surface residue not only trap snow, they also reduce wind and water erosion, limit evaporation from the soil surface, provide retention of soil moisture and increase humus formation, all crucial to the Kulunda region with its limited water availability.

2.1.1. Crop residue burning (CRB) and conservation tillage
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2.1.2. Policy measure investigated
Since 2001, CRB has been legally regulated in Russia, first by a Federal Code on the Administrative Torts passed in 2001 and then the 2002 regional Administrative Act on the Violation of the Justice in Altai Krai. The Federal Code did not explicitly refer to agricultural areas but the regional law specifies that “burning of crop residues on agricultural land, natural protected areas, in traffic zones or around water basins” will be penalized.5 The regional law was amended at the end of 2013, as the court concluded there is no need for two separate statutes. Federal and regional administrations issued a regulation, in force since 2014. The regulation prohibits burning on agricultural and forestry land but specifies: “burning of the crop residues on agricultural land is allowed under the following conditions: fire security of municipalities and infrastructure has to be ensured and it has to be proven that there is no other available mechanism how to dispose the crop residues.” Further conditions, such as that the burning can be done only by individuals or organizations that have the specific and authorized ‘extinguisher and anti-fire security qualification’ (Implementing provisions, 23.01.2014), conditions far too expensive for most farmers to satisfy, made the exemption clauses for the burning ban essentially absolute – on paper.

2.2. Methodological and analytical framework
The Procedure for Institutional Compatibility Assessment (PICA) methodology was used throughout this study. The methodology has been developed based on the assumption that policies, judicial systems and enforcement mechanisms for formal rules have to be congruent with the institutional environment which also includes informal institutions in order to be effective. However, as North (1993) has stated, it takes much longer for norms of behavior to evolve than it does to create formal rules. Here is the connection to the second theoretical approach that we link for building our conceptual framework. That is Williamson’s levels of social analysis (Williamson, 2000) which is used to explain the timespan it takes to change a formal or informal institution (detailed in Section 2.2.3).

2.2.1. Understanding institutions
In line with North, who studies how institutions evolve, we take a dynamic perspective on institutions, where formal and informal rules frequently interact. According to North (1990, p.3; 1993) North (1990, p.3, 1993), “Institutions are the rules of the game in a society or, more formally, are the humanly devised constraints that shape human interaction. In consequence, they structure incentives in human exchange and reduce uncertainty arising from interaction.” We continue to follow North (1993) in assuming that because actors have incomplete information and limited cognitive capacities, they need to develop a regularized pattern of rules and norms to structure the exchange.

We understand institutions as formal and informal rules. Based on North (1990, p.36), formal rules are laws, regulations (here, for example, the law and ordinance to ban crop residue burning) and constitutions. Informal rules are norms of behavior, conventions, self-imposed codes of conduct. North (1990) mainly focuses on formal rule change, which overlooks problems of their enforcement and the inertia of prevailing informal rules which might be not in line with the newly implemented formal rules. When formal rules are in conflict with the prevailing informal rules, the interaction of their accordingly conflicting incentives will tend to raise transaction costs of policy implementation. If formal rules should work effectively they must be complemented by informal constraints that supplement them and thus reduce enforcement costs (North, 1990, p.20). Because we face transaction costs and actors frequently must act on incomplete information, formal rules are adjusted in ways that might be inefficient, partly due to their incongruity with the prevailing informal institutions.

We reiterate that it takes longer for informal rules to evolve than it does to create new formal ones. North (1990, p.36) already point to the fact that many aspects and structures persist in a society in spite of a total change in the formal rules. Defining institutions as constraints, he notes that “informal constraints that are culturally derived will not change immediately in reaction to changes in the formal rules.” This leads to tension between altered formal rules and the persisting informal constraints (North, 1990, p.45).

2.2.2. PICA methodology and operationalization
The Procedure for Institutional Compatibility Assessment (PICA) is a standardized procedure for capturing the institutional dimension in policy assessment, which is still rare. The PICA methodology fulfills two characteristics that make a good fit to the envisioned aim of this study.
First, PICA explicitly considers institutional aspects of policy implementation. And second, PICA features an inherent search process to discover those institutional aspects that are particularly relevant either for the policy options under scrutiny (here, the ban on CRB) or for the particular regional institutional context (here post-socialist Russia) (Theesfeld et al., 2010). Further, most agri-environmental models used for policy assessment—although aware of the oversimplification—usually assume that with the implementation of a new policy, the institutional arrangements conducive for that policy will be perfectly in place, or that a suboptimal institutional arrangement will change automatically towards perfection at once and without costs. In addition, it is often assumed that all targeted actors will comply with the policy (Theesfeld et al., 2010). The main strength of PICA is to assess the compatibility of certain policy measures with the prevailing institutional environment (Ambland and Mann, 2011; Mandryk et al., 2015; Theesfeld et al., 2010) and thus particularly revise these problematic assumptions. The original PICA method proposed four distinct steps, of which the study at hand follows step 1) classification of policy options and step 2) identifying the crucial institutional aspects of those policy options.

We analyze in this study the crucial institutional aspects (CIAs) of implementing a regulation on CRB (Theesfeld et al., 2010). CIAs and policy-relevant agro-technological requirements can— with the help of PICA—be examined in a systematic manner to identify a facilitating or hampering institutional context. In the process of developing PICA, CIAs affecting policy implementation in agriculture, environment and rural development were distilled from the literature to create a library of 42 CIAs linked to re-
plementation in agriculture, environment and rural development were
provided by the indicators is used for a qualitative assessment of each identified CIA, and is further aggregated, leading to qualitative statements about the probable effectiveness of a policy option and the institutional fit or lack of fit between policy options and institutional contexts (Theesfeld et al., 2010).

PICA is an open concept where the researcher has to adjust the CIAs to be evaluated to the context, based on policy specifics, implementation requirements, regional characteristics, or known characteristics of actors. Thus, some of the initially listed CIAs for this policy type were not considered suitable for analyzing the effectiveness of the regulation on banning CRB, or for the socio-political background in Western Siberia, and were therefore not considered. The remaining revised list of ten CIAs was ranked and discussed with the interviewees. Which CIAs are valued as most important to determine policy effectiveness is presented in the result section of this paper. Finally, the ranked list of CIAs as one output of the interviews was grouped according to Williamson (2000)’s levels of social analysis, described in the following.

2.2.3. Policy incompatibility with institutions at four social levels

The literature suggests that implementation of particular land policies may fail because the regulations ultimately enforced are not compatible with the prevailing institutional environment (Theesfeld et al., 2010) and future interlinkages between newly set policy and institutions are ignored. If the individuals crafting and modifying such formal rules do not understand how particular combinations of rules affect actions and outcomes in a particular ecological and cultural environment, rule changes may produce unexpected and, at times, disastrous outcomes (Ostrom, 2005).

To structure the analysis and shed light on different sources of policy incompatibility in a regulatory approach, we apply the theory-based four levels of social analysis framework developed by Williamson (2000). Williamson (2000) originally pursued with this framework the idea of positioning different bodies of research and theory in a framework of four levels of social analysis. He discussed which theory is concerned principally with which level. Originally, this framework was not intended for policy analysis, but in recent literature it has been used this way, particularly because the time spans that Williamson highlights as needed for changing institutions at a particular level are appealing. Some studies apply the framework to explain the evolution of a new social institution to manage an agri-environmental system. Behera and Engel (2004) applied it to the analysis of the evolution of the Joint Forest Management in India, Hurrelmann (2003) to a description of agricultural land markets and Sultan and Larsen (2011) to the determinants for Chinese farmers to join an agricultural cooperative. Pollümae et al. (2016) have used the social analysis framework recently to study formal and informal institutional barriers in forest owner’s cooperatives in Estonia.

Fig. 2 depicts the four levels on which an institution functions and the time it typically takes to change institutions at each level. We assume that a soil protection policy that aims at changing the social behavior of actors—here reducing CRB—has to influence all four levels with appropriate policy measures in order to be successful in the long-term.

Level 4 deals with economic activities, where the issue is getting the marginal conditions right. Neoclassical economics (where people continually adjust prices and quantities to optimize marginal conditions) as well as theories of asymmetric information (including adverse selection and moral hazard problems) provide explanatory help for the social analysis at this level. Change in agricultural production habits oriented towards profit requires specific policy measures that also address this level. Changes at this level are constantly occurring.

Level 3 deals with the governance structures that make actors’ rights effective, e.g. property rights. Such governance structures are responsible for actual contract definition and enforcement, as well as conflict resolution mechanisms, information sharing mechanisms, or advisory service. Ideally, for each specific transaction there is an efficient, i.e. transaction-cost minimizing, governance structure. Changes at this level are not continuous, but take place in a relatively short time (one to ten years).

The second level refers to the institutional environment that human beings create through formal rules (e.g., constitutions, laws). Property rights are created on this level, determining who has what rights and duties to the use of a natural resource. Institutions on this level tend to change slower than at the previous level, in a time period of decades or centuries (Williamson, 2000).

Level 1 is the level of social embeddedness of the underlying values of societies, such as customs, taboos, and traditional norms. Such informal constraints are usually present in a society for a long period, take centuries or millennia to change, and are believed spontaneous in origin. They are taken as given by most institutional economists and policy analysts (Williamson, 2000). Although the social embeddedness level changes only very slowly, and can hardly be directly addressed by a policy, it has to be taken into account as a facilitating or hampering factor. It would be hampering, if the policy is incompatible with the underlying social values and thus cannot count on voluntary compliance.

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6 Step 1: The policy options are clustered to identify the generic structure of a policy option. Step 2: Each policy type is characterized by a specific set of crucial institutional aspects (CIAs). Step 3: Indicators help to evaluate the potential of respective CIAs to constrain or foster the implementation of a policy option. Step 4: The information provided by the indicators is used for a qualitative assessment of each identified CIA, and is further aggregated, leading to qualitative statements about the probable effectiveness of a policy option and the institutional fit or lack of fit between policy options and institutional contexts (Theesfeld et al., 2010).

7 A common CIA, for instance, is “information asymmetry between state and firms,” which is related to several policy types. The presence of information asymmetries may induce high costs for establishing a monitoring system to ensure actors’ compliance with a policy. Or, given a fixed low monitoring intensity, actors may find it safe to defect (Theesfeld et al., 2010).
The arrows that connect a higher (Level 1) with a lower level (e.g., Level 2) in the figure signify that the higher level constrains the level immediately below. For example, to address successfully the centuries-old traditions of burning crop residue, actions to change the formal institutional environment (pre-emptive entitlement of property rights on land) and its governance (monitoring mechanisms) as well as incentive structures (subsidies for adopting new conservation technologies) are crucial. The reverse arrows from lower to higher levels signal feedback that may eventually promote change at the higher level.

Although originally not developed by Williamson (2000) for this purpose, the framework is ideally suited to policy design, raising awareness of the time period needed to change an institution at a particular social level and thus, corresponding measures. Likewise, it allows us particularly to take into account the socialist style of governing and the cultural aspects inherited from socialism.

2.3. Data collection

The first step of data collection was an analysis of documents in the archives of the krai and its subordinate rayon units. Besides general statistical yearbooks of the Soviet Union and the Altai Krai, including those of the Federal Forest Agency (2016) and the regional Agriculture and Forestry Section (ROSTAT, 2016), special reports of the statistical office turned out to be relevant. Those are the report on “Main Indicators of the Economic and Social Development in the Altai Krai” (Statistical Office Altai Krai, 1994), and the “Report on the Land Ownership and Tenancy Rights” of the Federal Cadastral and Cartography Office (ROSESTR, 2013). Further, relevant national laws have been studied such as the “Land Code” (2001), “The Regulation on the Agricultural Land” (2002), the “Federal Code on Administrative Torts” (2001), the “Law about the Fire Security” (1994) and the “Implementing provisions regarding the burning of the droughty crop residues” (2014). Directed to the regional level, the “Administrative Act on the Violation of the Justice in the Altai Krai” (2002) was relevant. Legal documents which were not publicly available in the archives were accessed at www.consult@nt.ru.

A range of actors and organizations, their interests, values, conflicts and power struggles concerning policy implementation were identified from interviews and reading the documents, respectively. As listed in Table 1, in total, 24 semi-structured, problem-centered interviews were conducted in April-May 2014 and September 2015, each lasting between one and three hours. Interview dates were scheduled in advance, which sometimes required extensive and repeating oral and written explanations about the aim of the particular study in order to arrange a meeting at administrative bodies. Further, as expected, it turned out to be politically sensitive to discuss first, the extent of crop residue burning, and second, problems in policy implementation. Interview arrangements with the farmers were therefore much easier, yet here an official permission to do research in the countryside was required and was not always issued. We selected farms in four rayons, which differ in their distance from Barnaul, the Altai krai administrative centre, because we assumed monitoring difficulties would increase with distance: Kalanskij (70 km), Rebrichinskij (120 km), Mamontovskij (180 km) and Celinij (180 km). Further, the administrative rules for empirical work in the countryside changed frequently and were not always transparent to the researcher team. The interviews were held with an experienced translator from the region and partly organized with the help of local researchers well connected to the agricultural administration.

Interviewees included 15 managers of individual and privately held corporate farms, environmental NGO agents, a locally-based agronomist, an agricultural technology dealer, administrative staff (controlling and monitoring agency, fire patrol), actors dealing with policy execution of the Altai krai (Administration of Natural Resources and Environment, and Central Administration of Agriculture – which only provided a press report) and a member of the regional court.

In fact, creating a trustworthy interview atmosphere turned out to be extremely demanding. On the one hand, many officials in regional administrative bodies faced a restrictive information policy with top-down advice not to engage in interviews about difficulties in land use policy implementation. On the other hand, some members of these administrations expressed personal interest in an exchange of experience at other meeting occasions in the frame of the entire Kulunda research project. The Kulunda project is a German-Russian project which aimed at preventing “dust bowl” conditions in the Kulunda region, a goal likewise supported by these officials.

3. Results: constraints in policy implementation

Land use policy measures aiming at reducing CRB are still confronted by large areas set on fire every year. Annual satellite pictures show that the regional appearance of agricultural fires has not been significantly reduced (Federal Forest Agency, 2016). The CIAs that potentially hamper or foster the effective implementation of the respective policy type were adjusted as described above. We identified ten CIAs of possible relevance for the policy regulating CRB and for the

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Table 1
Interviewees and their Role.

| Actor (No. of interviewees) | Role and Function |
|-----------------------------|-------------------|
| Individual (peasant) farms (9) | Manager operating on 600–2000 ha |
| Cooperate farms or holdings (6) | Managers or agronomist of farms operating between 9000 and 27000 ha |
| Gehler Ecological Society (2) | Head of agricultural NGO |
| Agromist (1) | Locally-based agronomic expert |
| Administration of Natural Resources and Environmental Protection (CANREP) in Altai Krai (2) | Head of the Administrative Department, Executive staff of the Department of Ecological Governmental Control |
| Central Administration of Agriculture in Altai Krai (1) | Vice head (provided press report) |
| Water and Ecological Research Institute, Barnaul (1) | Scientist |
| Fire patrol (1) | Member |
| Regional court (1) | Member with law expertise |

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*In the Russian Federation a krai represents an administrative unit that has its own head, parliament and constitutional court. The Altai Krai is divided into 59 districts, called rayon. Part of the executive power is exercised by rayon committees.*
Table 2
Crucial Institutional Aspects for a Policy Regulating Crop Residue Burning.

| Revised list of CIAs (adapted from Schleyer et al., 2007) | Description | Level (Williamson, 2000) | Importance of CIAs (Yes, ranging from 6 = the most relevant to 1 = least relevant; No (0) hardly considered as relevant) |
|-----------------------------------------------------------|-------------|-------------------------|-------------------------------------------------------------------------------------------------------------------|
| Attitude of farmers towards land management change and ecological considerations | The tendency of farmers and workers to express environmental concerns and preferences and to behave favorably toward the environment | EMBEDDEDNESS | Yes (1) |
| Public concern about agri-environmental problems | Existence and relevance of agricultural/nature-oriented party; Votes for agricultural parties; Products with local labels, etc. | EMBEDDEDNESS | No (0) |
| Opportunistic behavior of farmers | Tendency to circumvent or avoid the regulation. | GOVERNANCE; EMBEDDEDNESS | Yes (2) |
| Property rights to land | Fragmentation of land rights; Institutional impediments to land rights and ambiguous property rights; Effective execution of the rights, etc. | INSTITUTIONAL ENVIRONMENT | Yes (3) |
| Capacity of state administration | Resources of administrative bodies to create, implement and evaluate an effective instrument. | GOVERNANCE | Yes (4) |
| Controlling and monitoring | Ability to monitor the policy, its compliance and coercion to change; Existence and extent of information asymmetry between administration and actors. | GOVERNANCE | Yes (5) |
| Contradictory policy measures and rules | Degree of measure’s contradiction or consistency with other policies. | GOVERNANCE | No (0) |
| Interplay between administrations | Quality of civil services and coordinated procedures between agricultural and environmental administrations; Design of synchronized regulations, etc. | GOVERNANCE | No (0) |
| Bargaining power of farmer’s organizations and environmental associations | Existence of and membership in farmer’s associations; Lobbying power and outreach of the associations, etc. | GOVERNANCE | No (0) |
| Transaction and adjustment costs for the farmers | Time and money that the actors have to spend in order to comply with the regulation. | RESOURCE ALLOCATION | Yes (6) |
| Bargaining power of supply industries (input delivery) | Monopolistic or oligopolistic structures among machinery suppliers; Availability of inputs and price conditions, etc. | RESOURCE ALLOCATION | No (0) |

Regional institutional context.

First, interviewees voted for the three most important CIAs of that revised CIA list and were then asked to rank these three by assigning three, two, and one points. That resulted in the ranking summarized in Column 4 of Table 2. We marked the four CIAs with the least points as being not considered as an important CIA. We weighted each individual ranking the same, being aware of a bias, as two-third of interviewees were farmers. This can be seen in the result that the transaction and adjustment costs for the farmers turned out to be the most important, although not all members of that group ranked it as most important. However, for our further discussion, we do not depend on the specific CIA ranking by actor group. Rather, the general importance of a CIA and the additional explanations of the interviewees depict valuable information, as presented below.

Second, during qualitative interviews respondents described and commented on the intensity of an aspect and the direction (facilitating or hampering policy implementation) of its influence. For instance, more environmental awareness and ecological considerations facilitate environmental policy implementation, whereas more opportunistic behavior of farmers hampers such policy implementation. Table 2 summarizes the six CIAs that turned out to determine policy effectiveness.

In the following, the six CIAs evaluated as most important in influencing effective policy implementation are structured along the Williamson’s levels of social analysis, as indicated in Column 3 of Table 2.

3.1. Resource allocation: adjustment costs

The prevailing technology on arable land in Altai krai entails burning harvested crop residues, and tillage operations each season (combined tillage) with various wide blades or with knife tillers that cut the roots of weeds. In order to comply with the burning ban, farmers would need to change to a form of conservation tillage, used up to now on approximately only 5% of the cropland in the investigated area (Belajev, 2009). Farmers would face the following difficulties in tilling residue-laden fields:

- Investment in new machinery to handle the straw and roots left from the previous year’s harvest: Direct seeding equipment must be designed to operate in heavy residue conditions and in soils that have much wetter surfaces than in conventional tillage systems. An agricultural technology dealer for Central Asia and Russia estimates the costs for a multifunctional sowing machine, which is capable of seeding in straw, to be 150.000 Euro. Such machinery is either largely unavailable in Russia or incompatible with the old Russian tractors used. The ability to chop and disperse residues uniformly across the cut is also critical, but most grain harvesters are not equipped with straw choppers. The cost of a straw chopper for the old Soviet harvesting machine is specified by the expert at 2.000 Euro.
- Investment in fertilizer and pesticides: Unlike nutrients from inorganic fertilizers, macronutrients in crop residues are not readily available. For straw to decay sufficiently requires microbiological processes in the soil not possible in the short vegetative period in the Kulunda region. Instead, the decomposition of residues will actually withdraw nitrogen from the soil, and without additional nitrogen fertilizer spread on the field, the short-term productivity of the soil will be reduced while the residue will harbor insects (Smil, 1999; Soane et al., 2012). As a result, conservation tillage practices, ranging from zero-tillage to minimum tillage, require more fertilizers and pesticides although they provide an estimated yield increase of 20–25% after a couple of years. Figures from Kazakhstan show clearly this agronomic relationship (FAO, 2012). Zentner et al. (2002), who could study a longer time-series in the Canadian Prairies, likewise support this.

The respondents in the case study declared that high investment
costs coupled with farm budget constraints restrict technological innovation. Such findings can be supported by Ahmed et al. (2015) who analyzed why farmers burn rice residues in Pakistan. Cost implications seems to be the main socio-economic factor in deciding among the alternatives – removing or incorporating the residues. One decisive factor is the ease with which required innovative farm machinery can be obtained for preparing the subsequent wheat seeding operations on residue-laden fields. For instance, Russian farmers gave a range for interest rates for agricultural credits from 14 to 25% and complained about high additional processing costs. Almost equally assessed between individually operated farms and larger entities, such as corporate farms or holdings, such restrained credit access is the most frequent factor preventing farmers from complying with the regulation. Further, farmers believed that burning crop residues is the simplest way to dispose of residues and make the field ready for next season. Farmers said they also consider non-monetary adjustment costs, such as having to learn new skills or dealing with new suppliers, when they assess whether to change production practices.

3.2. Governance: monitoring and prosecution, missing agricultural advice

Williamson’s second level (Williamson, 2000) concerns the governance structures which makes the policy effective. Command-and-control approaches are usually effective only if applied to easily observable soil conservation problems (Prager et al., 2011). Though fires are observable, who sets them may not be. Prager and Posthumus (2010) have shown that for Europe, credible sanctioning is the main driver for compliance with conservation requirements. Prager et al. (2012) found that farmers typically perceive a low threat of penalties. Contemporary Russia, far more than Europe, lacks land administrative capacity representing land information infrastructure and building the basis for land policy implementation, just as it does for support of a functioning land market (Lerman and Shagaida, 2007; Williamson, 2001).

In the Kulunda region, the ability to identify a rule-breaker suffers from the asymmetry of information held by controllers versus land users. The responsible agency which monitors compliance in the Altai krai is the Administration of Natural Resources and Environmental Protection (CANREP). This agency governs the majority of policies that relate to environmental protection on agricultural, forest and industrial areas, manages natural protected areas, executes the law on air protection, maintains anti-erosion forest belts and executes hunting regulations. Total staff to accomplish all this amounted to 24 specialists in 2014, supported by five members of the fire patrol. CANREP uses publicly available satellite pictures with registered fires (“kosmos-nimky”) to detect illegal fires and their extent. In addition, Rosleschoz – the organization responsible for forest management – publishes data about identified field fires. The Grabler Ecological Society is actively involved in the patrolling of fires to help put the fires out. Even so, farmers confirmed that staff capacities are not sufficient to monitor the large area involved and its over-600,000 agricultural companies and (semi)subsistence household units. Additionally, CANREP’s overlapping responsibilities do not allow for sufficient investigation. The agency admitted that the proportion of violations that ended up with prosecution of offenders is lower than 5%.10

Prosecutors are required to provide specific evidence in order to find the accused person guilty. Only in few cases did farmers admit they initiated the fire. In other cases they claimed either other causes of the fire or an unknown person was responsible. Moreover, the relatively low level of fines, 30–40 Euro, is not dissuasive, interviewees said. The exceptional conditions for allowing burning, in force since 2014, have put even more administrative burdens on the controlling agency, such as investigating whether the potential offender had no alternative than to burn the residuals.

At the same time, hardly any public information campaign on the policy goal or alternative agricultural production planning has been launched. Indeed, none of the official available documents quantified the targeted level of fire reduction. Similarly, the farmers were mostly not informed about the general benefits of conservation tillage practices to support rule compliance. Many farmers complained of a lack of information about the complexity of yield decrease and cost increase in the first years of shifting from traditional tilling technology (including residue burning) to conservation technology. Similar relationships are recently found for Australia by Dumbrell et al. (2016) where farmers are less likely to adopt carbon sequestration practices if the impact on productivity is uncertain. This supports findings of Prager et al. (2012) for other post-socialist countries, that advisory systems are key requisites for the implementation of soil protection policies and conservation requirements.

3.3. Institutional environment: property rights on land

The next level focuses on the institutional environment: the formal rules of the game, especially property rights arrangements, and how they impact the regulatory measure (Williamson, 2000). It has been argued that property rights, whether de facto or de jure, significantly affect the incentives individuals face when investing in long-term land improvements (Brassele et al., 2002), such as increasing organic content over time. Farmers without formal private land ownership titles have less incentive to improve the organic content, particularly when straw burning is less costly short-term. Qualifying Lerman and Shagaida (2007)’s conclusion that agricultural land in Russia has been largely privatized, in the Kulunda region the current proportion of land in private possession is about 58% (ROSREESTR, 2013). Although the relationship between the extent of private land ownership and the propensity to follow conservation tillage practices is complex (Brassele et al., 2002), the interviewees in the Kulunda Steppe often declared that with the increasing amount of privately owned land they are more willing to apply the conservation land practices and are willing to invest in the soil fertility.

A factor that confuses fire prosecutions is the public “easement” right on land (so called “servitude”). Stemming from the time when land was used in common in Russia, this right allows anyone free access to any plot. Members of the court complain that, however illogically, farmers would cite this to suggest unknown persons might have set the fires on their land.

3.4. Embeddedness: perception and trust

Farmers are known to be conservative people – not changing their habits frequently. Farmers stated that, due to the long history of land tenure in common, even preceding the Soviet era, they partly prefer to use the land that way and do not see the need of individualizing land rights. During socialism agricultural production was driven by production intensification objectives. Recent evolving soil protection measures are comparatively new.

Longstanding perceptions weigh against the fire ban. In post-socialist Lithuania, Pereira et al. (2016) have shown that the perception of the impacts of fires determines the farmers’ reaction to fire regulation. Analogously, in the Kulunda steppe, beliefs were widespread (about two-thirds of interviewed farmers) on the positive effects of residue burning on the soil, such as reducing weeds and pests. Not surprisingly, these farmers regard fire regulation as an obstacle to farming. Further, as Schneider et al. (2010) stressed for Switzerland, a switch to no-till farming means farmers have to change their perception of the aesthetics of cultivated land and thus their underlying values.

Similar to studies from Bulgaria and Czech Republic (Prager et al., 2012), we found low trust in officials as information providers, due to

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10 The larger farms rate is slightly less important.
11 Personal communication with the staff at CANREP.
the communist legacy where government officials worked to conceal information. Such failure of trust is detrimental for any policy that is based on voluntary measures or otherwise would entail prohibitive high transaction costs in controlling and sanctioning – and particularly so for a policy that runs counter to long-held beliefs.

4. Discussion and conclusion

Based on a case study of the Kulunda Steppe in South-Western Siberia, we explore how far a command-driven land policy, here the ban on crop residue burning, fits the prevailing institutional and social context and the agro-technological requirements. We offer a structured depiction of the reasons the policy measure is ineffective, which would otherwise help to combat soil degradation. The assessment of policy compatibility, as used here, could be applied generally to the wider problem of land use policy implementation; it highlights and reminds researchers and policymakers of the extent to which ecological, economic, social, and institutional systems are mutually dependent.

Following Williamson (2000)’s four levels of social analysis (according to how frequently they change), critical factors were embedded in all four levels of social interaction. It turned out that factors at the resource allocation level – high adjustment costs to reduce crop residue burning without being compensated – are a core constraint on change to conservation tillage practices. At the governance level, we found an enforcement problem, since voluntary commitment is lacking. High costs of monitoring and the near-impossibility of convicting the offender make the policy ineffective. Meanwhile at the institutional environment level, the lack of land-ownership discourages the investment for long-term benefit to that land that the new policy would provide. The strength of embedded beliefs and traditions, signaled by farmers’ attempts to cite customary common access to land as a defense against prosecution for fire-setting, clearly hinders policy implementation. At this social embeddedness level, farmers have deeply rooted beliefs about the presumed advantage of residue burning. Failure to advise and educate farmers on the broader policy goals of fighting soil degradation, and agro-ecological benefits of alternative land use systems for their specific soil types, meant the government provided nothing sufficient to start the long process of belief change.

While the adjustment costs and the governance of the controlling mechanism can be addressed in the short-term, the factors connected with the land tenure system and particularly the personal attitudes of farmers towards soil conservation will only change slowly and can persist even over generations; some determinants require so much time to change that they easily exceed the time span of a political program. Thus, isolated measures that address the problem of crop residue burning only at one social level do not go far enough. Another difficulty with environmental measures is the time span of ecological processes: humus accumulation in soil, for instance, is a process whose benefits can only be measured long-term. Yet, the temptation is to propose short-term policies, with arguably visible and measurable results. As our analysis shows, such policies are difficult to implement.

In the final form the policy took in 2014, the administration has paid particular attention to the formal introduction of the measure and its bureaucratic arrangement (information exchange, regular reporting). This increased monitoring capabilities significantly, but did not consider farmer’s needs for the technological innovations in conservation tillage that would simultaneously lead to regulation compliance. At the same time, the updated law imposed even more unsupported duties on the monitoring agency.

Drawing upon this case, we recommend that government and allied NGOs, motivated by the long-term, undertake measures aimed at the long-term problems: shifting farmers’ beliefs and property rights institutions to favor soil conservation. To address beliefs, a public information campaign or stronger advisory system, preferably including model conservation tillage plots observable on field days to farmers, should be created, accompanied by pragmatic education. Further subsidies should be provided to offset the initial resource allocation costs of conservation. To address property rights, the transaction costs of confirming and transferring land titles should be reduced. These measures move towards forms of governance that count on voluntary participation by educated actors. That direction will reduce governance problems for land use policies, but will encounter its own difficulties in a political and administrative environment with a command and control legacy, such as Russia. Yet to truly address soil degradation problems with long-term solutions, first steps must be taken on the long road to changing fundamental beliefs and creating supportive institutions.

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