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Sustainable Fishery Management Regulatory Compliance on the Pandam Wildlife Park Lakes: an Ordered Probit Analysis

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Abstract
This paper analyzes the causes for regulatory compliance using socio-economics, deterrence, legitimate and social variables. The study uses fisher's self-reported data from Plateau State artisanal fishers in Lake Pandam. The data were analysed using ordered probit regression model and corrected least square regression model on subsample of occasional violators. The results indicate that fishers could adjust their violation rates with respect to changes in socio-economic variables as well as to deterrence, legitimacy and social variables. Furthermore, 46.67% fishers were non-violators, 40% were occasional violators, while 13% were persistent violators. Persistent violators react neither to normative aspects nor to deterrence variables, but systematically violate the regulation and uses unclear means to avoid punishment. We recommend transparent enforcement using the deterrence variables and monitoring must increase and that penalties should be higher.
Keywords: compliance, regulations, legitimate, deterrence, violators

1 Introduction

Fisheries have been regarded until very recently as an extractive industry whose development was identified with increased extractive capacity (Bohnsack, 1993). As a result, FAO (2003, 2007) reported that global captured fishery is in a crisis with a majority of the world's fisheries being fully exploited and about one third of them being either depleted or over-exploited. This crisis has been brought about by both market and policy failures which manifest themselves through among other things, improper management and inadequate property rights.

Until recently, fishery biologists, conservationist have shown considerable support for direct government regulatory management of fisheries with protected areas, reserves formation, seasonal closures, entry limitations, and gear restrictions (Walter, 2000). Fisheries economists have viewed regulations as valuable in conserving habitat, biological diversity and revenue generation and tourist can enjoy them Bohnsack (1993)

The Plateau State Government in central region of Nigeria for the last nine years (2004) adopted a contemporary fisheries management mechanism at Pandam Wildlife Park lakes fishery – *Close Season, Limited Entry and Mesh Size Limit*. It is believed to satisfy sustainable fishing criteria such as low investment cost, adaptation to local skills, output to meet basic needs of local people, create new employment, environmental harmony, profit generation and continuity of harvesting. However, to date, there is no known study to investigate fishers' compliance or violation rate. And this study is intended to look at compliance or otherwise of fishers to close season regulations at the lakes.

2 The objectives of the study

The main objective of this study was to be to construct an analytical tool to describe, analyse and model how management regulations are complied to. The specific objective is to evaluate the level of compliance or otherwise of fishermen to close season regulations at the Pandam Wildlife park lakes fisheries.

3 Hypotheses

This study tested the following null hypothesis; there was no close season regulations violation among licensed fishers at the Pandam Wildlife Park Lakes Fisheries.

4 Literature review

Fish is a major source of protein for many poor people (UNEP, 2002) almost half of the world's landings are from tropical waters (Pauly, 1996) and from countries where development is at a low or medium level. These fisheries are frequently open access with no restrictions on entry or total catch, and regularly lack even rudimentary tools for management. The seminal contribution by Pecker (1968) basically outlines a choice between the legal and the illegal options. The major determinant for this choice is the expected payoff, which simply put, is a function of the risk of being punished, the expected punishment and the net profit from violating the law.

On the other hand, it is socially desirable that enforcement policy creates marginal deterrence, which rules out the use of severe penalties for relatively mild violation such as fishing a closed area or landing fish below minimum size. Recent research in the social sciences also extends the deterrence model to include normative aspects of complying with the law such as personal morality and legitimacy (Tyler, 1990).

The original deterrence model by Becker (1968) led to a large number of empirical papers testing the hypothesis Erlich, (1973) and Gaviria, (2000) is a recent extension, which by and large confirmed the theory. Whether the deterrence conclusion is confirmed has been debated, however, and one level of critique is methodological. If crime rate is defined as crime per capita, and probability to be arrested is measured as the ratio of arrests to crimes. We have the number of crimes in the denominator of the independent variable and in the numerator of the dependent variable crime can imply spurious correlation.

Finally, more crimes lead to more expenditure on law enforcement, which implies a simultaneous relationship between crime and enforcement levels. Manski (1978) suggested survey-collected individual self-reports as a means of avoiding these problems, since each individual will have a negligible impact on each of the three objections raised. Furlong (1991) applied these ideas to Canadian fishers and found the fishers to be most sensitive to changes in the likelihood of detection, while fines appeared to create the greatest deterrence among various penalties.

Social science research on why people follow the law has been dominated by the instrumental perspective, which is based on deterrence literature and reaches the same policy conclusion as the economics research following the Becker approach. However, given the weak deterrent threat facing people for minor violations, this approach cannot explain why the vast majority of people act in a way consistent with the law (Robinson and Darley, 1997) contributions to legal thought, which to a large extent are revivals of older ideas, provide several suggestions. One reason for following the rules is to avoid the disapproval of your social group; another is that you see yourself as a moral being who wants to do the right thing (Robinson and Darley, 1997). A third factor is legitimacy, which means that the individual feels that the authority enforcing the law is entitled to dictate behaviour. This in turn depends on whether individuals think that the law is fair and applied in a fair manner. Whether legitimacy is maintained or undermined is dependent on people's experiences with legal authorities (Tyler, 1990).

Enforcement in fisheries has been a fairly neglected area (Sutinen and Hennessey, 1986). The early contributions are theoretical and deal with optimal stock if non-zero enforcement costs are introduced (Sutinen and Andersen, 1986 and Milliman, 1986) and his choice of optimal government policy (Anderson and Lee, 1986). The first empirical study confirmed the deterrence model showing that an increased risk of detection and conviction reduce the violation rate in a fishery (Sutinen and Gauvin, 1989). The simple deterrence model predicts that most fishers will violate the regulation if the risk of detection is low, fines are modest, and the profits from violation are substantial. Still, a vast majority of fishers in various fisheries seem to comply with the regulation, which contradicts the predictions based on this model (Sutinen and Kuperan, 1999; Eggert and Ellegard, 2003). Extended analysis is therefore necessary to include both the judgemental and the normative perspective.

The empirical evidence from such an approach is mixed; Kuperan and Sutinen (1998) found that compliance in a Malaysian fishery depended on the tangible gains and losses, as well as the moral development, legitimacy, and behaviour of others in the fishery. Hatcher et al. (2000) found less evidence in favour of normative influence on fisher compliance, while again confirming the deterrence effect. These studies deal with trawl fisheries where the capital input is substantial, but this study is the first to analyze artisanal fishers of the Plateau State government regulated fishery. The fishers in the sample all have low levels of capital inputs, i.e. they operate simple open wooden-hulled vessels.

The ordered probit model has come into fairly wide use as a framework for analyzing such response Zavoina and McElvey, (1975). It is often found that for any regulation there is a small subgroup of persistent violators (Feldman, 1993) a condition which seems to also exist in fisheries (Kuperan and Sutinen, 1998). It is also believed those who always obey (violate) the rules may on some occasions be attracted to deviate from their normal behaviour, but lack the

possibility to do so. A simple reason could be that the enforcement authorities at the lake (guards) may be on patrol (absent), which implies that the model will fit those who actually alternate between violation and compliance. But excluding the others would lead to information wastage and biased estimates, as it was a voluntary participation. Moreover, when decision process by farmers to adopt a new technology requires more than one step, models with two-step regressions are employed to correct for the selection bias generated during the decision making processes.

By the same token, Eggert *et al.* (2008) employed the Heckman's selection model to analyze the two-step processes of regulatory compliance in Lake Victoria fisheries. Thus, this study adopts the Heckman's two-step procedure (Heckman, 1976) to analyze the factors that affect violation rate categories and factors influencing occasional violators in the close season regulation in the Pandam Lake fishery. In the first step of the analysis, the probability that a given individuals fisher will violate the close season regulation was determined from an ordered probit model using all observations from the fishers in the three categories. In the second step, the least square regression method was used in the regression of the sub-sample of occasional violators. Using least square method has advantage that it allows one to directly interpret the parameter in the selection model as conditional marginal effects.

5 Description of the Pandam Lake Fisher

The Pandam lake reserve fishery is the only natural lake reserve inland water body in Nigeria that employs current management programs that includes three major activities; *limit entry, mesh size restriction and a close season*. The Pandam lake reserve fishery remains an ideal example of how a lake close season management is carried out. Regulatory restrictions include; a closed season, minimum size limits (3.5mm) and a limited entry programme.

A full closure is in effect from 1st June to 31st October every year; at this period the lake remain totally closed to fishing activities by licensed fishers. In total, the number of days closed to fishing activities is 153 and the number of potential open days per year is approximately 212, the close period or seasons coincides with spawning periods. Furthermore, limited entry programme permits only 30 licensed fishers to fish every day for the period of open season in the fishery. Pandam Lake gives one kilogram of fish every day to government officials and sells the rest for their income. The fishers use mostly wooden dug-out canoes and fishing gears such as gillnets, *malia* traps, *gura* traps and hook lines in both systems.

6 Methodology

6.1 Study Area

Pandam Lake is about 200 hectares located within the Pandam wildlife Park which lies within the Northern guinea Savannah in the middle belt plateau state of Nigeria. Plateau state lies between latitude 8o30′ and 10o30′N, longitude 7o30′ and 3o37′E with a land mass covering 53,585 square metres, the state has an estimated population of 3.67 million (NPC, 2013).

6.2 Data Collection

Primary data were employed for the research and collected using written questionnaires administered to the government licensed and regulated fishers of Pandam Lake and information collected include: socioeconomic characteristics, perceptions, and self- reported violation and compliance indicators.

6.3 Model specification

To determine the violation or compliance behaviour of fishermen to regulations of close season, we use two step Heckman procedures. In the first step, the *ordered probit* model utilizes a form of discrete choice models. The socioeconomic variables were continuous variables, while the deterrence, legitimacy and social variables were all measured by a four-digit scale. However, in the final analysis, these answers were re-coded as dummy variable with levels three and four being one, while, one and two being zero, where one represents fishermen who agreed with the statement and zero otherwise. The ordered probit model was specified implicitly as follows:

$VL^{*} = xi\,'\beta + \varepsilon.$ - - - - - - - - (1)

VL^{*} is unobserved

Where, X is a vector of an observable variable possibly governing VL^{*}, and ε is normally distributed with mean O, and standard deviation. Data on VL^{*} are only observed when VL = j for some j in (0, 1, 2), where O is for non-violators, 1

is for those who violated for one to five times (occasional violators), and 2 is for those who violated frequently (Persistent violators).

The ordered probit model was explicitly specified as follows:

$$VL = x' \beta + bi\ \beta + pi\ \beta + si\ \beta + \mu \quad - \quad - \quad - \quad - \quad - \quad - (2)$$

Where; VL= $\begin{cases} 0 \text{ If } v^* \leq \mu 1 \\ 1 \text{ If } \mu < v^* < \mu 2 \\ 2 \text{ If } v^* \geq \mu 2 \end{cases}$

X1 = Age of fishermen (number of years)

X2 = Educational status (number of years)

X3 = Experience in fishing (number of years)

X4 = Family size (number of dependence)

b1 = Expected gain from catch from illegal fishing (high =1, low = 0)

b4 = Close season regulations is not effective (yes = 1, N0 = 0)

P2 = Number of past arrest of fisher (number)

P3 = Subjective probability of being detected and caught (low = 0, high = 1)

P4 = Subjective probability of being detained if arrested (low = 1, high= 0)

P5 = Probability of being taken to court and convicted (low = 1, high = 0)

S2 = Number of others you think are violating regulations (number)

S3= Do your peer /friends think violation is right or wrong? (Right = 1, wrong = 0)

S4= Do they seek your opinion during the design of regulation (No = 1, yes = 0)

S5= Close season regulation is not enforced consistently (yes = 1, No = 0)

S6= Close season regulation improves the well-being of a few? (Yes = 1, No = 0)

S7= Penalty given to offenders or violators fit the offense (Yes = 0, No = 1)

S8= Enforcement at lake is not adequate (Yes = 1, No = 0)

S9= Many offender are not detected (Yes = 1, No = 0)

S10 = Close season regulation is not fair (Yes = 1, No = 0)

v* is not observed and v is its observed counterpart, $X_{i,}$, b_i, pi and s_i are vectors of explanatory variables, μ_1 and μ_2 are threshold parameter to be estimated with the β's, the subscript i is index of the individual and the error term μ is distributed as standard normal (Greene, 2003).

7 Results and Discussions

The descriptive statistics of variables used and estimates of violation category for regulated fishermen are reported in Tables 1. The results indicated that 46.67% of the respondents are non-violators, 40 % are occasional violators and 13 %, are persistent violators. These results suggest that less than half of the fishers at Pandam Lake showed absolute compliance to management regulations.

Table 1 Descriptive Statistics of Variables included in the Estimates:

Variables Name	Description	Min	Max	St.Dv	Mean	Coefficient Variation.
Socioeconomic variables						
Age of fishers		23	75	14.66	45.67	0.32
Educational status		0.0	12	4.73	6.16	0.77
Experience in fisher		10	55	12.80	27.20	0.47
Family size		1.0	35	9.43	9.76	0.18

Deterrence variables					
Expected gain from catch of illegal fishing	0.0	1.0	1.02	1.70	0.21
Close season regulations is not effective	0.0	1.0	1.06	1.10	0.12
Number of past arrest of fisher	0.0	7.0	2.19	1.70	1.2
Subjective probability of being detected and caught	0.0	1.0	0.97	1.76	0.55
Subjective probability of being detained if arrested	0.0	4.0	1.06	1.90	0.55
Subjective probability of being taken to court/ convicted	0.0	1.0	1.02	1.70	0.34
Social and legitimate variables					
Number of others you think are violating regulations	0.0	1.0	6.42	6.36	1.01
Do your peer /friends think violation is right or wrong?	0.0	1.0	1.10	1.43	1.13
Do they seek your opinion during the design of regulations	0.0	1.0	0.91	1.93	0.47
Close season regulation is not enforced consistently	0.0	1.0	0.95	1.83	0.42
Close season regulation improves the well-being of a few?	0.0	1.0	1.05	1.27	0.83
Penalty given to offenders fit the offence	0.0	1.0	0.97	1.40	0.69
Enforcement at lake is not adequate	0.0	1.0	1.01	1.06	0.59
Many offenders are not detected	0.0	1.0	0.96	1.63	0.36
Close season regulation is fair	0.0	1.0	0.41	0.20	2.0

7.1 *The Ordered probit model;* estimated using the LIMDEP econometric software and presented in Table 2, shows the threshold parameter (μ) was highly significant at 1% level of significance (LOS), indicating that the three categories in the responses were indeed ordered (Liao, 1994). The study evaluates the marginal effects of significant variables from the ordered probit model which are more reliable. The result indicates that many variables are statistically significant across all of the subgroups of deterrence, socioeconomic, social and legitimacy variables.

Table 2: Estimate of Ordered Probit Model Probability of Violation Rate

(0= non- violator, 1=occasional violator, 2= persistent violator)

Variables description	Coef	P (Zi>z)
Age of fishers	-0.42**	0.043
Educational status	-0.056*	0.068
Experience in fisher	0.49**	0.032
Family size	-0.13	0.134
Expected gain from catch of illegal fishing	1.64**	0.022
Close season regulations is not effective	0.57	0.239
Number of past arrest of fisher	0.58	0.140
Subjective probability of being detected and caught	1.51	0.118
Subjective probability of being detained if arrested	0.37	0.359
Subjective probability of being taken to court/ convicted	1.50*	0.095
Number of others you think are violating regulations	0.08	0.440
Do your peer /friends think violation is right or wrong?	-0.17	0.699
Do they seek your opinion during the design of regulations	-3.30**	0.054
Close season regulation is not enforced consistently	-2.55*	0.065
Close season regulation improves the well-being of a few?	-0.41	0.431
Penalty given to offenders fit the offence	-0.41	0.332
Enforcement at lake is not adequate	4.07**	0.023
Many offenders are not detected	-0.044	0.401
μ = Rho statistics	0.438***	0.0010
Log likelihood functions	=-15.797	
Chi-squared	= 33.74	
Degrees of freedom χ^2 ,17,095	= 27.58	
Prob [chi sqd > value	= 0.0029	

***,**,* Significant at 1%, 5% and 10%respectively

The marginal effects of ordered probit model of the statistically significant variables are presented in Table 3 and these measures the decreased (increased) in probability that the fisherman would be in the violation category, given a unit

change in the particular independent variable with other variables held at their means. If the independent variable is a dummy, its' interpreted to mean the increase (decrease) in probability if the binary variable is equal to one. The result indicated that the marginal effect for a fisherman being a close season non-violator for *education* was 0.182. This suggests that the probability for a fisherman being a non-violator will increase by 18% for every extra year of formal schooling he/she gets. Education was not particularly significant for persistent violators, but marginal effect shows an interesting signs. This reveals that for an extra year in formal schooling, the probability of a fisherman being a persistent close season violator will decrease by 11%.

The results show that the probability of fisherman being in the non- violation category will decrease by 15% with an increase in a year of experience. This finding confirms Lokina (2008) for Lake Victoria fisheries, in which they found that experienced fishermen tend to violate mesh size regulations more. *Expected gain from violation* was the only significant deterrent factor. This may mean if *expected gain from illegal fishing* (b_1) is high or increasing, then non-violators are likely to become occasional violators. The result also reveals that some variables from the social and legitimate subgroups were statistically significant, factors relating to perception of legitimacy and social influence impact on the decision to be a non-violator of the close season regulation or to contemplate breaking the rule.

The statistical significance of *fishermen views considered in design of regulations (S4)*, indicates that the higher the fishermen perceived that their opinion were sought during the design of regulations, the higher the probability of fisherman to remain a non-violator. Also the higher the fishermen perceived their opinion were sought during the design of rule, the lower the probability of occasional and persistent violators to remain.

The result also shows that if *fishermen perception of the government imposition of regulation* (S_5) was wrong, then the probability of being an occasional violator or persistent violator will also increase, while the probability of remaining a non-violator decreases. The result further suggested that if the close season is seen *to improve the well being of few* (S_8), then there will be a higher probability of non-violators to move to occasional violators, while the probability of being occasional and persistent violators will increase. This result may confirm our face-to-face interview with the fishermen who believed the government was not sensitive to their suggestions, that management of the lake should reduce the close period to two or three months, But there was no response from government yet.

Table 3: Marginal Effects of Significant Variables

Variables	Non-violators	Occasional violators	Persistent Violators
Socio-Economic Characteristic Variables		**Coefficients**	
X_1 = Age of fishers	0.137**	-0.053*	-0.084
X_2= Educational status	0.182**	-0.070	-0.112
X_3= Experience in fisher	-0.158**	0.061*	0.97
Deterrence Variables			
B_1=Expected gain from catch of illegal fishing	-0.529**	0.203*	-0.325
P_5= Subjective probability of being taken to court/ convicted	-0.483**	0.185	0.297
Social And Legitimacy Variables			
S_4 = Do they seek your opinion in the design of regulations	1.06**	-0.408*	-0.654
S_5 =Close season regulation is not enforced consistently	0.822**	0.316*	0.505
S_8= Enforcement at lake is not adequate	1.311**	0.50**	0.806

*, ** significant at 1% and 5% respectively

7.3 *Corrected Least Square Estimate.*

The results of the least square estimation of subsample on occasional violators are reported in Tables 4 and 5. Using the corrected least squares, two separate models were fitted because of the problem of degree of freedom on the combined data. In the first corrected LS regression (Table 4), the socio-economic and deterrence variables were regressed on occasional violation rate. The adjusted R-Square was found to be 0.619. This suggests that the variables included in the model explain at least 62% of variation in violation of regulations. The rho(ρ) statistics was -0.77, while the whites test value of 7.44 at 3 degrees of freedom and 5% LOS, confirms the normality assumption of OLS. The result also show that all socio-economic variables were statistically significant with *Age (X_1)* and *family size (X_4)* showing negative signs. This implies that as the fishermen increase in both age and number of dependence, there is a high probability of moving from occasional violator to non-violator.

For the deterrence variables, four subjective probabilities have the expected negative sign with the exception of the *subjective probability of being detected (P_3)*. They were also statistically significant with the exception of *subjective probability of being detained if arrested (P_4)*. The insignificance of this variable could reflect the level of commitment of managers to enforcement. This may suggest and point to the fact that bribes or other forms of gratifications would have been offered to avoid punishment for violation.

Table 4: Corrected L S Estimate of Socioeconomic and Deterrence Variables

Variables description	Coefficient	t-ratio
Constant	6.84**	7.203
X_1 = Age of fishers	6.84*	7.203

X_2 = Educational status	-3.30*	0.054
X_3 = Experience in fisher	-0.176*	-3.88
B_1 = Expected gain from catch of illegal fishing	0.269*	2.17
B_4 = Close season regulations is not effective	0.509	-1.52
P_2 = Number of past arrest of fisher	0.546*	-3.57
P_3 = Subjective probability of being detected and caught	1.298**	5.03
P_4 = Subjective probability of being detained if arrested	0.307	-0.93
P_5 = Subjective probability of being taken to court/ convicted	-0.904**	-3.40
Rho statistics	-0.77	-0.670

Adjusted R – square = 0.61

White test chi-square = 7.45

Lagragain statistics (LM) = -44

3 Degrees of freedom. χ^2 = 7.81

*,** Significant at 1% and 5% respectively

7.4 *The corrected Least Square regression estimates using legitimacy and social variables*

The adjusted R-Square was found to be 0.625 suggesting that the variables included in the model explain at least 63% of variation in violation of regulations. The rho (ρ) statistics was -0.025 and White`s test value of 7.68 at 4 degrees of freedom and 5% LOS, confirms also the normality assumption of OLS. The result presented in Table 5 shows strong evidence that the participation was positive (P<0.000) and most variables of the subgroups show strong statistical significance.

The social variables; *number of others believed to be violating the regulations (S_2)*, *number of times you were arrested in the past year (B_4)* and *does your peers/friends think that regulation is right or wrong (S_3))*, all show statistical significance. The negative sign of B_4, means fisherman tend to stop violating as rate of past arrest increases, furthermore, if fishermen perceived that others are violating the close season regulations, there is a *higher probability for them to violate too(S_3).* The variables *government was right to impose regulation (S_5), close season regulation is adequately enforced (S_9) and Close season regulation is fair (S_{11})* were all negative and statistically significant. This result means that government imposition of regulation, perception of fair regulation by fishers and an adequate enforcement of close season can reduce the probability of violations by occasional violators.

Generally, the results of social and legitimacy variables point to fact that their influence on the violation rate were high confirming their influence on decision of fishers on whether to be non-violators or to violate the regulation. This is so because those who do violate are still influenced by the perceived compliance rate among their colleagues. If they think many others violate the close season then the probability to comply will be low. Furthermore, they tend to comply if their perception is that fisher opinion was *considered in the regulation designing*; and *if they believed the regulation is fair.*

Table 5 Least Square Estimate of Social and Legitimate Variables

Variables	Coeff	t-ratio
Constant	-0.950	-1.042
B_4= Close season regulations is not effective	1.975**	-5.78
S_2 = Number of others you think are violating regulations	0.153*	7.88
S_3 = Do your peer /friends think violation is right or wrong?	3.42*	9.09
S_4 = Do they seek your opinion during the design of regulations	8.34*	7.54
S_5 = Close season regulation is not enforced consistently	-4.48*	-6.99
S_6 = Close season regulation improves the well-being of a few?	2.34*	6.57
S7 = Penalty given to offenders fit the offence	2.18**	4.87
S_8 = Enforcement at lake is not adequate	6.68*	7.80
S_9 = Many offenders are not detected	-7.34*	-9.80
S_{11} = Close season regulation is fair	-5.81*	-10.90
Rho Statistic	-0.025	-0.136

Adjusted R-squared = 0.625

Whites test chi-square = 7.60

Lagragian statistics (LM) = -22

4 degrees of freedom χ^2 = 9.48

*,** significant at 1% and 5% respectively

8 Conclusion and policy implications

The behaviour model analysis highlighted some key factors about socioeconomic, deterrence, social and legitimates variables and points to the fact that regulatory fishery managers can improve compliance by good governance if fitted to a restricted number of significant factors, with appropriate considerations of aspects related to the social and/or to the productive structure could generate, through the voluntary acceptance of regulations by fishers, considerable gains in terms of management efficiency. Fishery managers should retire persistent violators if identified at the fishery as this will help management achieve its goal of compliance and further act as deterrent in itself to intended violators. Further imposition of regulations to fishing lake areas should be set in order to be more coherent with the local characteristics of lake resources and with the socio-economic context. This could be reached by adjusting regulations to the specific features of the host community. At the same time it should not be in conflict with aspects related to the income stability of the community impacted by it. This could have positive result both in terms of the perceived effectiveness and of perceived fairness. In this way a trade off between income/employment and natural resources protection could be avoided and/or better balanced.

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