

Article

Effect of Climate and Land-Use Changes on a Threatened Forest Resident Bird

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Abstract: Endangered species are being threatened by climate and land-use changes. However, the relative effects of climate and land-use changes on forest resident birds remain unclear. In this study, we employed an ecological niche model to forecast the potential influence of climate and land-use changes on Reeves's pheasant (*Syrnaticus reevesii*), while taking into account topographical limitations. We observed that climate and land-use changes would have a remarkably negative impact on *Syrnaticus reevesii*, and climate change would play a dominant role. Consequently, the potential distribution range of *Syrnaticus reevesii* would sharply decrease, and this species may face a significant risk of extinction in 2070. In addition, we found that the area change predicted by climate and land-use changes would be significantly lower inside the China Nature Reserve Network (NNR) than outside the NNR. However, less than 15% of the area suitable for *Syrnaticus reevesii* has been covered by NNR. Furthermore, our results showed that the response of *Syrnaticus reevesii* to climate and land-use changes largely depended on topographical factors, and *Syrnaticus reevesii* would face greater impacts from climate and land-use changes under topographical limitations. Taken together, we highlight that it is imperative to adjust and develop nature reserve networks and conservation strategies to cope with rapid global environmental change.

Keywords: forest resident birds; *Syrnaticus reevesii*; climate change; land-use change; risk of extinction



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1. Introduction

Climate change has caused substantial shifts in biodiversity and ecosystem structure [1,2]. Rapid climate change will directly and indirectly alter the quantity and quality of habitats [3,4], thereby shaping the distribution range of species [5,6]. Under climate change scenarios, range shifts may reduce the adverse effects of climate change on species [7,8]. However, species with poor dispersal ability and resistance may fail to track their favorable climate niche fast enough, thus eventually suffering extinction [9,10]. Additionally, land use is changing rapidly as a result of human activities and climate change, and it can alter species distribution by inducing habitat fragmentation, degradation and even loss [11]. Climate and land-use changes may jointly regulate bird distribution [12]. Therefore, land-use and climate changes have been widely regarded as major threats to biodiversity [13,14]. However, the relative effects of land-use and climate changes on endangered birds still remain largely unclear.

Topographical factors, including altitude, slope and aspect, may control macroclimatic and microclimatic conditions, subsequently resulting in significant shifts in land use or habitat conditions [15]. Therefore, topographical factors may have a great impact on bird distribution [16], similar to how the rugged and discrete topography of East Asia influenced relict plant species during the Paleogene–Neogene and earlier [17]. However, topographical conditions such as large mountains can impede the migration of species from adverse habitats to suitable ones to track their environmental niche [15,18]. As a consequence,

topography may have both favorable and adverse effects on endangered species related to climate and land-use changes [19]. For instance, previous studies have reported that the effects of land use and climate change on species distribution largely depend on topographical factors [20]. Hence, taking into account topographical constraints to comprehensively examine the impact of climate and land-use changes on species distribution may provide valuable suggestions for endangered bird conservation.

Classed as Vulnerable on the IUCN Red List of Threatened Species, Reeves's pheasant (*Syrnaticus reevesii*) is endemic to China and is a flagship species in some of the mountainous areas of central China. It plays an important role in maintaining natural forest reserves [21]. Unfortunately, its distribution range is gradually shrinking and has divided into two isolated parts, thus inducing a population decline [22,23]. In addition, land-use types (i.e., vegetation types) have been demonstrated to have an important influence on its distribution [24]. Due to its fragmented distribution range and small population size (46% of sites disappeared), *Syrnaticus reevesii* is quite sensitive to environmental changes and human disturbance, like habitat loss, grazing, illegal hunting, etc. [25]. Therefore, testing the influence of climate and land-use changes on *Syrnaticus reevesii* is critical for biodiversity conservation under global change [26,27].

To predict the potential response of *Syrnaticus reevesii* to climate and land-use changes, we collected 394 occurrence records during field observations in 2019. The maximum entropy approach was applied to predict the range shifts of *Syrnaticus reevesii* under different scenarios of climate and land-use changes. Specifically, our study attempts to answer two questions: (1) How will climate and land-use changes affect the distribution range of *Syrnaticus reevesii*? (2) What roles do topographical factors play in the range shifts of *Syrnaticus reevesii* under climate and land-use changes?

2. Material and Methods

2.1. Species Occurrence Data

The study sites are distributed in five provinces in central China: Anhui, Guizhou, Henan, Hubei and Shanxi (Figure 1). Field surveys were conducted between January and November 2019 in the entire region where the distribution of *Syrnaticus reevesii* has been recorded since 1980, including seven provinces/municipalities directly under the central government, namely Anhui, Guizhou, Henan, Hubei, Hunan, Shaanxi and Chongqing. Based on previous records, *Syrnaticus reevesii* is primarily distributed in the mountain systems of the Qinling Mountains, the Dabashan Mountains, the Wuling Mountains, the Daloushan Mountains, and the Dabie Mountains. The line transects and infrared camera traps were randomly placed based on previous patrol routes. Then, 100 camera traps (Ltl Acorn 6310 WMC, Zhuhai, China) were exclusively used in the Dabashan Mountains from January to December 2019. The distance between any two camera traps was greater than 0.4 km. The camera traps were placed at a height of 30 cm. Cameras were set to operate 24 h per day, and they were programmed to take up to 3 photos once triggered, followed by a 10 s video, with a 30 s interval to trigger the next photograph. Batteries and memory cards were replaced every three months.

In total, 221 sample lines were deployed (see Table S1 in the Supplemental Materials), covering a distance of 930.72 km, and 100 infrared camera traps were utilized. A total of 524 location records (417 from line transect, 107 from camera stations) of *Syrnaticus reevesii* were collected in field surveys. To reduce potential data errors, records with duplicate locations were removed [28]. To our knowledge, our survey covered nearly all *Syrnaticus reevesii* habitats. Overall, a total of 394 records (130 were removed) were used in this study.

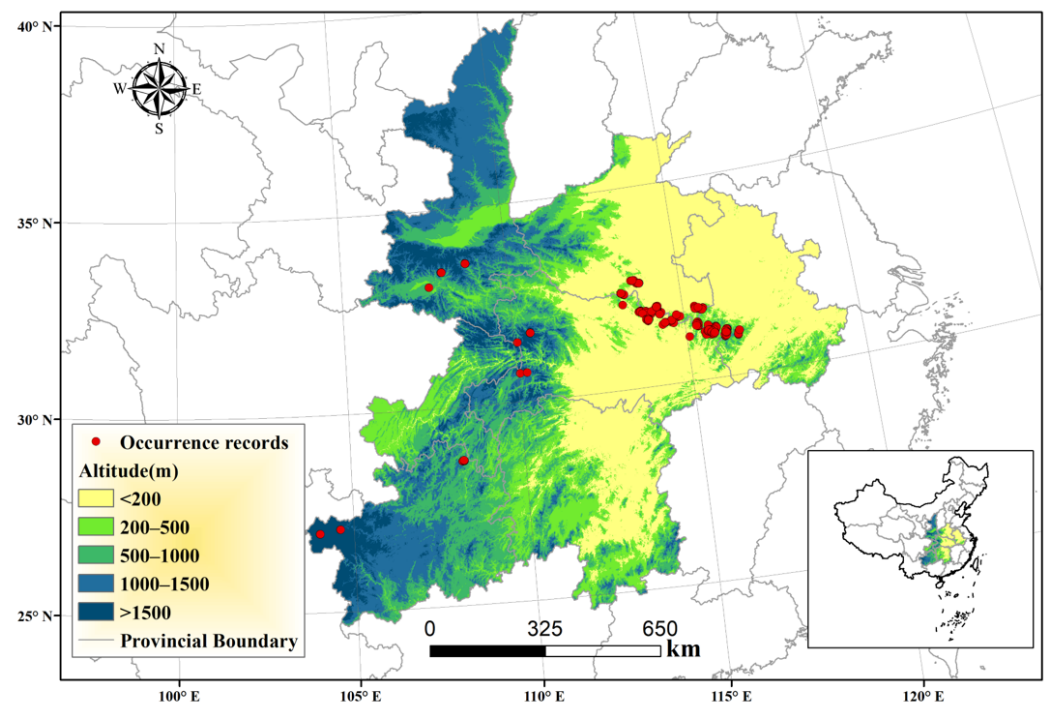


Figure 1. Occurrence records of *Syrmaticus reevesii* under current scenario.

2.2. Climate, Land-Use and Topographical Data

First, we obtained the digital elevation model data (with a resolution of $1\text{ km} \times 1\text{ km}$) from the Data Center for Resources and Environmental Sciences, Chinese Academy of Sciences (<http://www.resdc.cn>, accessed on 4 September 2019). Next, altitude, aspect and slope were calculated and utilized to indicate the topographical complexity and steepness [29]. Then, we acquired 19 bioclimatic parameters for the present (averaged from 1950 to 2000) and future climate scenarios (using 2070) from the WorldClim worldwide climate database (<http://www.worldclim.org>, accessed on 4 September 2019). The data had a spatial resolution of $1\text{ km} \times 1\text{ km}$ [30]. For the climate projections of 2070, our research incorporated estimations from three distinct global climate models (GCMs): BCC-CSM1-1, MIROC5 and CCSM4 [28,30].

We obtained data on land-use patterns for both the present and future scenarios from the FROM-GLC Model database [31], with a spatial resolution of $30\text{ m} \times 30\text{ m}$. Featuring eight general land-use categories (forest, shrubland, grassland, cropland, water, bareland, impervious and snow/ice), the FROM-GLC Model offers global land-use datasets for the period of 2010 to 2100. Similar to climate datasets, land-use datasets encompass four representative concentration pathways (RCP 8.5, RCP 6.0, RCP 4.5 and RCP 2.6) that outline the most pessimistic and optimistic projected concentrations of greenhouse gases (GHGs) for the coming decades. This study examined the potential impact of land-use and climate changes on the distribution of *Syrmaticus reevesii* across three emission scenarios (RCP8.5, RCP4.5 and RCP2.6). RCP 8.5 denotes a pessimistic scenario with stabilization projected at 8.5 global radiative forcing in Watts per meter squared (W/m^2) by the year 2100. Likewise, RCP 4.5 stabilizes total radiative forcing at $4.5\text{ W}/\text{m}^2$ by 2100 through the use of various technologies and strategies to reduce GHG emissions. RCP 2.6 predicts a decline in global radiative forcing from $3.1\text{ W}/\text{m}^2$ in the mid-century to $2.6\text{ W}/\text{m}^2$ by 2100, representing the most optimistic scenario with low GHG concentrations.

2.3. Species Distribution Model

In this study, the suitable distribution region of *Syrmaticus reevesii* across different climate and land-use change scenarios was calculated MaxEnt 3.4.1 [32]. MaxEnt models have demonstrated improved performance when utilized with presence-only data [33,34],

allowing for the simultaneous incorporation of both categorical and continuous parameters into the model [35]. Spearman's correlation analysis was conducted to reduce strong collinearity among environmental variables, and nine variables were selected (Spearman's $\rho^2 < 0.6$) to model the potential suitable distribution of species, including Annual Mean Temperature (Bio1), Isothermality (Bio3), Temperature Seasonality (Bio4), Mean Temperature of Driest Quarter (Bio9), Annual Precipitation (Bio12), aspect, altitude, slope and land use (Figure S1).

The implementation of the model involved utilizing two randomly sampled subsets of occurrence records, with 25% allocated for testing data and 75% for training data. To mitigate the effects of artificial errors, we conducted 500 iterations and 10 replicates by repeatedly splitting the samples [36]. In addition, we configured all parameters according to the previously recommended default settings [32]. The model performance was tested using an area under the receiver operating characteristic curve (AUC) with 10-fold cross validation [37]. In addition, the prediction accuracy of each model was evaluated using AUC values, and a model with an AUC value greater than 0.7 was regarded as a well-fitted model [38,39].

The threshold that maximizes the sum of specificity and sensitivity (Max SSS) was employed to transform probability occurrence results into binary categories (i.e., binary results: absent and present ranges). The utilization of the Max SSS threshold in species distribution models has been widely adopted as a means to reduce the average error rate [40]. Notably, the potential suitable distribution of each representative concentration pathway scenario was obtained by averaging the final binary results from three GCMs, following a previous study [30]. To minimize the selection of a substantial amount of less informative pseudo-absences [41], the modeling was restricted to a bounding box (representing the seven regions in Figure 1) that covered the current ranges of *Syrmaticus reevesii*, plus an extended area outside that perimeter. This methodology has been widely adopted in previous studies [42]. In addition, the relative contributions of climate, land use and topography were calculated in percentage [32,43].

2.4. Statistical Analyses

The binary models for species distribution (SDMs) were converted to the coordinate systems of the WGS 1984 (World Geodetic System) using ArcMap 10.2, followed by estimating the overall extent of the distribution areas. To more clearly compare the range shifts of *Syrmaticus reevesii* under different scenarios of climate and land-use changes, we assessed stable range (current suitable habitats that remain suitable under environmental changes) and lost and gained ranges by comparing the future and present distribution ranges [44]. The shifts in potential suitable distribution were calculated based on the difference between range gain and loss, reflecting species range expansion, shifts and shrinkage between present and future scenarios [45]. To reveal the influence of the limiting effects of topography, the SDMs were run twice. Initially, we executed SDMs solely incorporating climate and land-use variables, followed by the implementation of MaxEnt models to replicate the distribution ranges without topographical factors (SDMWT) and with topographical factors (SDMT). We assessed the limiting effects of topographical factors by comparing the results of the two models.

3. Results

3.1. Predicted Potential Suitable Distribution of *Syrmaticus reevesii*

When MaxEnt models were performed with topographical constraints, the values of training AUC and testing AUC ranged from 0.987 to 0.989 and from 0.971 to 0.989, respectively. Similarly, when MaxEnt models were conducted without topographical constraints, the values of training AUC and testing AUC ranged from 0.984 to 0.986 and from 0.958 to 0.993, respectively. These results indicated that both models of SDMT and SDMWT had excellent predictive accuracy. The binary distribution and presence probability under current and future climate and land-use changes are shown in Figures 2 and 3 and

Figures S2 and S3, respectively. As expected, the potential suitable distribution ranges of *Syrmaticus reevesii* varied between SDMT and SDMWT. More importantly, the potential suitable distribution ranges in SDMWT were much larger than those in SDMT under all scenarios (Figure 4).

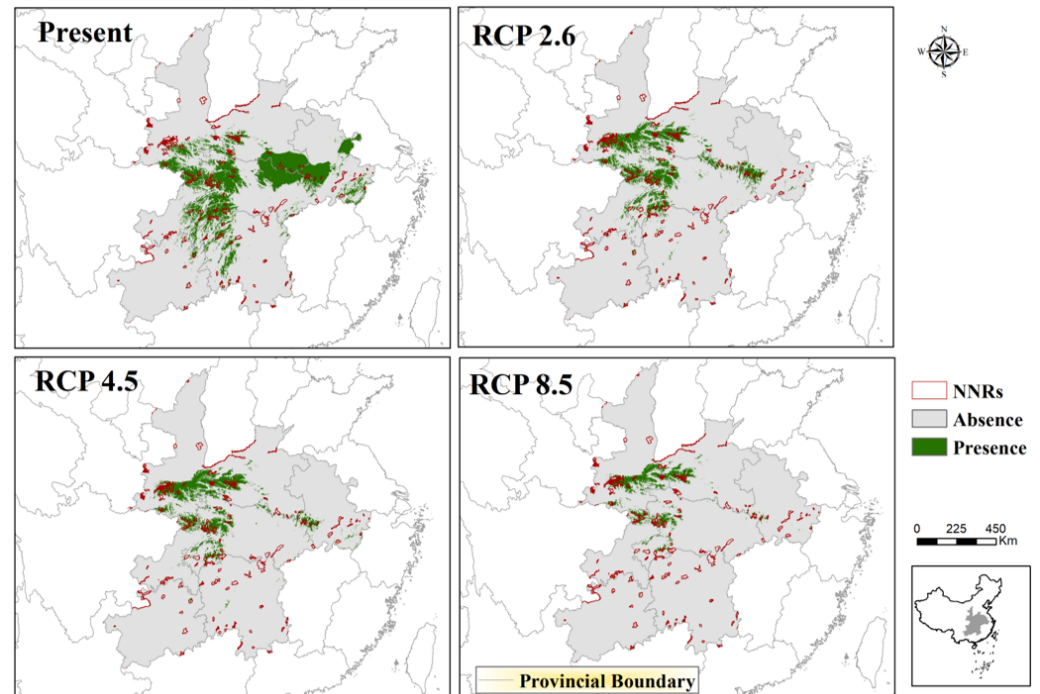


Figure 2. Binary distribution maps for *Syrmaticus reevesii* under current and future (RCP 2.6, RCP 4.5 and RCP 8.5 in 2070) environmental conditions, simulated by SDMWT (without the constraints of topography).

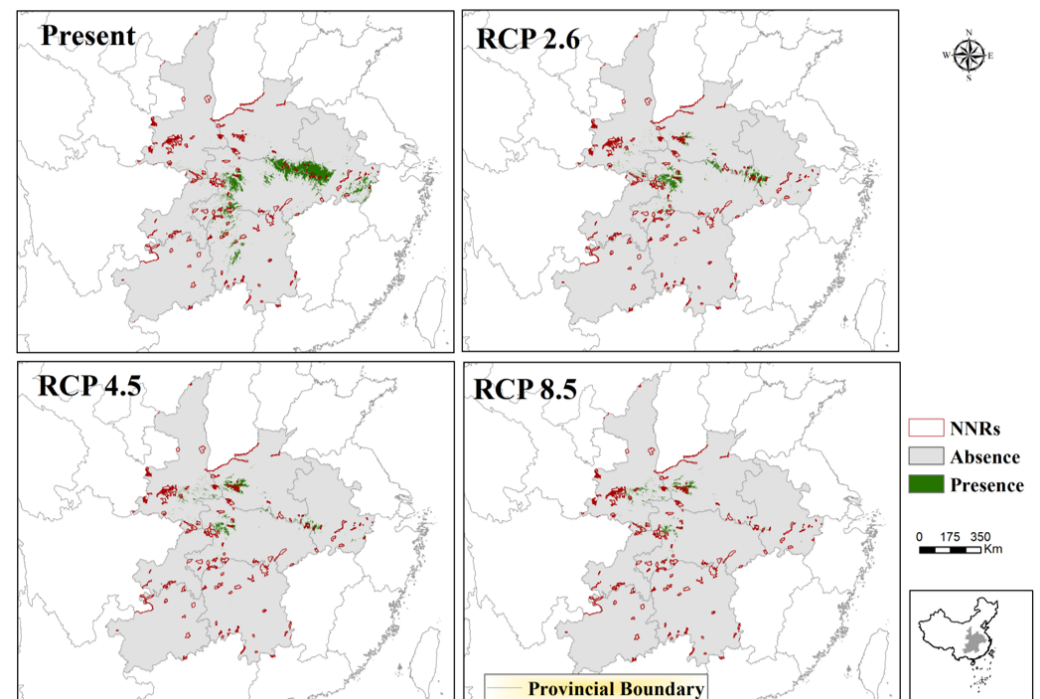


Figure 3. Binary distribution maps for *Syrmaticus reevesii* under current and future (RCP 2.6, RCP 4.5 and RCP 8.5 in 2070) environmental conditions, simulated by SDMT (with the constraints of topography).

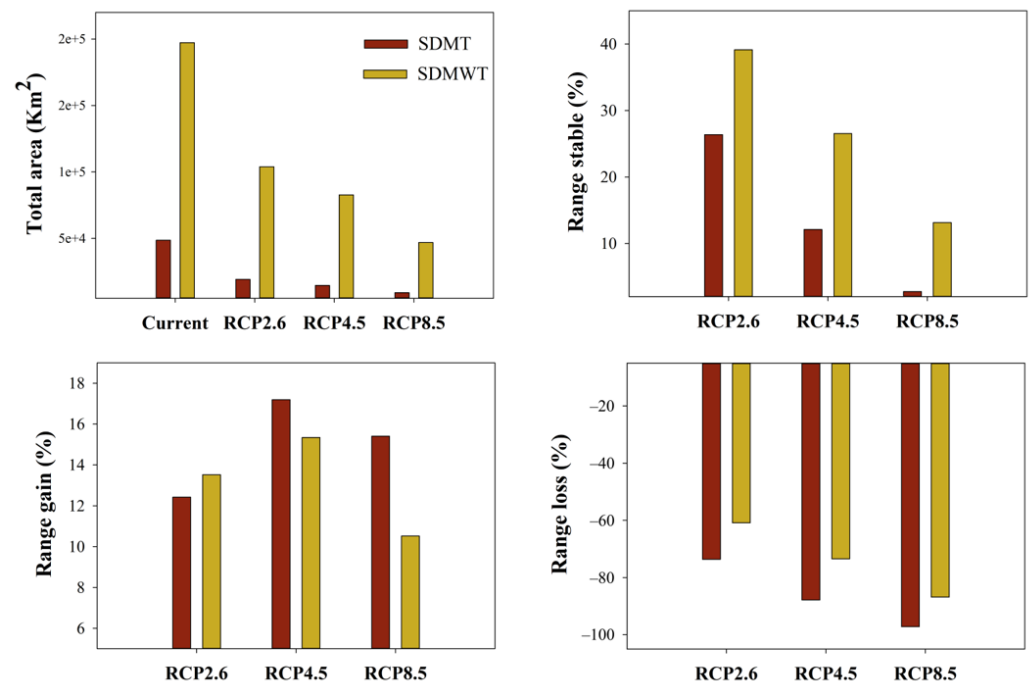


Figure 4. The range loss and gain components for *Syrmaticus reevesii* between SDMT and SDMWT.

3.2. Changes in the Potential Suitable Distribution Range of *Syrmaticus reevesii*

Both results of SDMT and SDMWT demonstrated that both land-use and climate changes would lead to substantial shifts in the potential suitable distribution of *Syrmaticus reevesii*, as shown in Figures 2 and 3. However, the response of *Syrmaticus reevesii* would vary between SDMT and SDMWT (Table 1, Figure 4). In SDMWT, the potential suitable distribution area of *Syrmaticus reevesii* would decrease at an average ratio of -60.51% (average values of -47.30% , -58.04% and -76.22%) across the RCP 2.6, RCP 4.5 and RCP 8.5 projection scenarios (Table 1). In contrast, the results of SDMT showed that the potential suitable distribution area of *Syrmaticus reevesii* would shrink at an average ratio of -70.51% (average values of -60.51% , -69.89% and -81.13%) across the RCP 2.6, RCP 4.5 and RCP 8.5 projection scenarios (Table 1).

Table 1. Potential suitable habitat change of *Syrmaticus reevesii* under future environmental change scenarios (RCP 2.6, RCP 4.5 and RCP 8.5 in 2070).

Scenarios	SDMs without the Constraints of Topography (SDMWT)	SDMs with the Constraints of Topography (SDMT)
	Area Change (%)	Area Change (%)
RCP2.6	−47.30	−60.51
RCP4.5	−58.04	−69.89
RCP8.5	−76.22	−81.13

To comprehend the internal range shifts of *Syrmaticus reevesii*, we divided the overall range change into two components: range gain and range loss (Figures 4–6). The results of SDMWT showed that *Syrmaticus reevesii* would lose 60.86%, 73.46% and 86.85% (with an average value of 73.72%) of its original habitat under the RCP 2.6, RCP 4.5 and RCP 8.5 scenarios, respectively (Figures 4 and 5), while the results of SDMT showed that *Syrmaticus reevesii* would lose 73.62%, 87.88% and 97.22% (with an average value of 86.24%) of its original habitat under the RCP 2.6, RCP 4.5 and RCP 8.5 scenarios, respectively (Figures 4 and 6). Notably, *Syrmaticus reevesii* would gain 13.12% and 15.07% on average in SDMT and SDMWT, respectively (Figure 4). Meanwhile, *Syrmaticus reevesii* would

retain 13.76% and 26.28% of its original habitat in SDMT and SDMTWT, respectively (Figure 4). These findings may indicate that *Syrmaticus reevesii* would experience greater range shrinkage under topographical constraints than without topographical constraints.

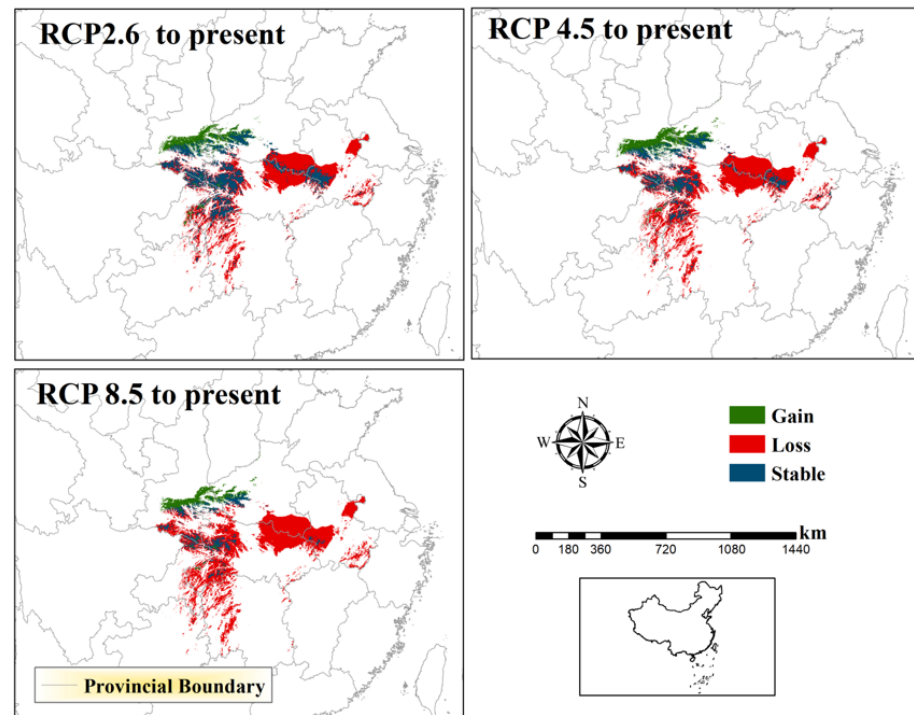


Figure 5. Spatial change in the potential suitable distribution ranges for *Syrmaticus reevesii* between current and future environmental conditions, simulated by SDMTWT (without the constraints of topography).

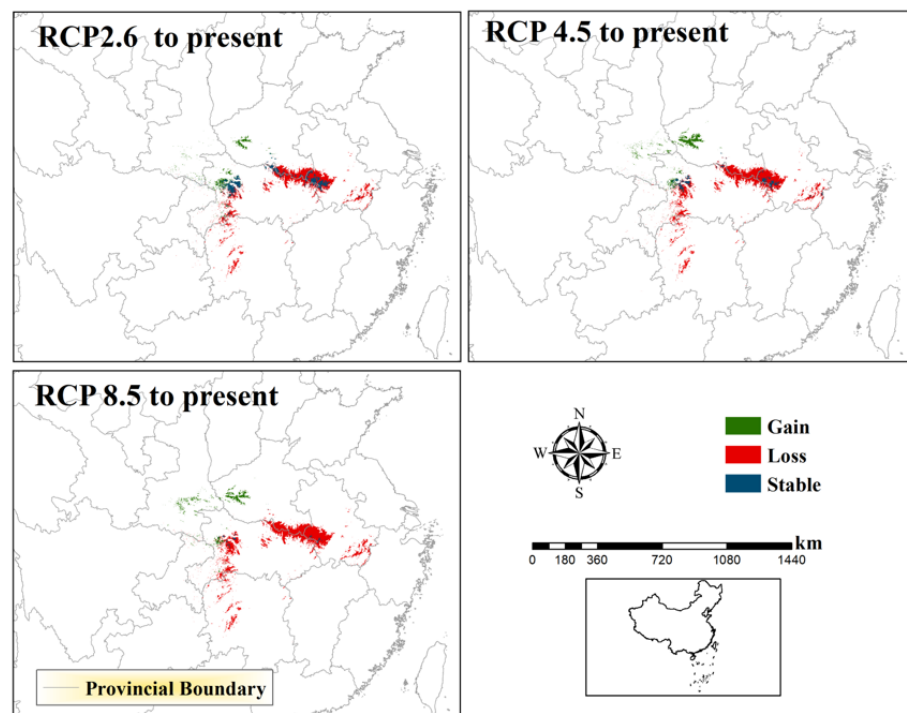


Figure 6. Spatial change in the potential suitable distribution ranges for *Syrmaticus reevesii* between current and future environmental conditions, simulated by SDMT (with the constraints of topography).

We also observed that only a small proportion of the suitable distribution area of *Syrmaticus reevesii* was covered by the China National Nature Reserve Network (NNR) (see details in Table 2). In the SDMWT analysis, the average decrease in the potential suitable distribution area of *Syrmaticus reevesii* within the NNR was -21.64% , while outside the NNR, it was -62.97% (Table 2). Additionally, in the SDMT analysis, the average decrease within the NNR was -37.05% , compared to -72.60% outside the NNR (Table 2).

Table 2. Potential suitable habitat change of *Syrmaticus reevesii* in NNR and outside NNR under future environmental change scenarios (RCP 2.6, RCP 4.5, and RCP 8.5 in 2070).

	SDMs without the Constraints of Topography			SDMs with the Constraints of Topography		
	Covered by NNRs (%)	Area Change in NNRs (%)	Area Change Outside NNRs (%)	Covered by NNRs (%)	Area Change in NNRs (%)	Area Change Outside NNRs (%)
2010	5.94			5.88		
RCP2.6	10.45	-7.24	-49.83	11.00	-26.11	-62.65
RCP4.5	11.60	-18.03	-60.56	12.66	-35.16	-72.06
RCP8.5	15.07	-39.65	-78.52	15.61	-49.89	-83.08

3.3. The Contribution of Climate, Land Use and Topography to the Potential Suitable Distributions of *Syrmaticus reevesii*

Five selected climatic factors together had the greatest relative contribution (76.11%) to the potential suitable distribution of *Syrmaticus reevesii* (Table 3). Among climatic factors, water-related variables (Bio12), temperature (Bio9) and climatic seasonality (Bio4) showed the strongest influence on the potential suitable distribution of *Syrmaticus reevesii* (Table 3). However, both land use and topography also played an important role in driving the potential suitable distribution of *Syrmaticus reevesii*, with a relative contribution of 16.72% and 7.17% , respectively. Among topographical factors, aspect played a more important role in shaping the distribution of *Syrmaticus reevesii*.

Table 3. Relative contribution rates of individual variables to the potential suitable distribution of *Syrmaticus reevesii*.

Climate					Land Use	Topography		
Bio1	Bio3	Bio4	Bio9	Bio12		Aspect	Altitude	Slope
0.37%	0.06%	17.89%	23.18%	34.62%	16.72%	5.69%	1.44%	0.04%

4. Discussion

4.1. Future Potential Suitable Range of *Syrmaticus reevesii* under Climate and Land-Use Changes

It is widely believed that climate and land-use changes may generate an adverse impact on a large number of species [45]. However, species with different migration and adaptation abilities may have distinct responses to climate and land-use changes [46,47] and experience various types of range shifts (i.e., shrinkage, expansion and shifts) in the face of global environmental changes [20,30]. In this study, the results of SDMT and SDMWT demonstrated that the potential suitable distribution area of *Syrmaticus reevesii* would decrease at an average ratio of -70.51% and -60.51% under climate and land-use changes (Table 1), suggesting that future climate and land-use changes will have an adverse influence on *Syrmaticus reevesii*, thus causing a substantial range shrinkage [45]. We also found that *Syrmaticus reevesii* would lose an average of 86.24% and 73.72% of its original habitat, indicating that this species will experience habitat loss or even extinction under environmental changes [48]. In addition, our results showed that the ratio of original range loss increased with increasing greenhouse gas emissions, which is consistent with the findings of earlier studies on endangered plants [20]. This implies that higher greenhouse

gas emissions may increase the extinction risk of *Syrmaticus reevesii* [48]. In fact, *Syrmaticus reevesii* is a large terrestrial resident bird with a very limited capacity for long-distance dispersal, thereby having a much higher extinction risk under future climate and land-use changes. In brief, this study provides reliable evidence that *Syrmaticus reevesii* will be negatively influenced by anticipated climatic and land-use changes.

4.2. Roles of Climate and Land-Use Changes in Shaping the Potential Suitable Distribution of *Syrmaticus reevesii*

Our results showed that both climate and land-use changes had an important influence on the potential suitable distribution of *Syrmaticus* species, suggesting that climate and land-use changes will jointly alter the potential suitable distribution of endangered birds [25,49]. In contrast to previous studies of other species [30,49], we observed that climatic variables had a more powerful influence than land-use variables on the potential suitable distribution of *Syrmaticus reevesii*. There are three probable interpretations: First, it is an issue of scale. Previous studies have reported that land use plays a dominant role at a finer scale of habitat to landscape and of less than 20 years [50]. However, we examined the influence of climate and land-use changes on species distribution at the scale of continents and more than 50 years. Second, climate change has a significant influence on land use, and it is difficult to quantify their independent influence precisely due to strong collinearity. Third, the primary distribution of *Syrmaticus reevesii* occurs within evergreen and deciduous broad-leaved forests [24,51], whereas our land-use data could only be categorized into broader and less precise classifications, such as data for grasslands and data for forests [31], which may lead to an underestimation of the impact of land-use changes on *Syrmaticus reevesii*. It is also interesting that both temperature and precipitation had a substantial effect on species distribution, while precipitation played a more important role (Table 2), implying that both climate warming and changing precipitation will alter the potential suitable distribution range of *Syrmaticus reevesii*, but this species will be more sensitive to changing precipitation.

4.3. Topography Governs the Response of *Syrmaticus reevesii* to Climate and Land-Use Changes

Many previous studies have found that topographical factors can significantly affect the potential suitable distribution range of species [15,52] and modify the influence of climate and land-use changes [51]. *Syrmaticus reevesii* is an endemic species in the mountainous regions of central China, which primarily inhabits mountainous forests at altitudes ranging from 400 to 1500 m above sea level, with a particular preference for mountainous broad-leaved forests or mixed forests characterized by complex topography and uneven terrain, sometimes reaching altitudes of up to 2600 m above sea level. Additionally, *Syrmaticus reevesii* has a preference for areas with eastern and southern slopes, as well as gentler gradients, and a particular affinity for areas with higher vegetation cover. In our study, we observed that both altitude and aspect had an effect on the suitable distribution range of *Syrmaticus reevesii* (Table 2). Additionally, we also found that the suitable distribution range of *Syrmaticus reevesii* was significantly larger in SDMWT than in SDMT, implying that this species faces an increased risk of extinction due to inadequate topographical conditions, notwithstanding favorable climate and land-use conditions [15,53]. Meanwhile, we also found that the geographical range of species distribution also differed obviously between SDMT and SDMWT, indicating that topography plays a key role in shaping the suitable distribution of endangered birds, and SDMs without topographical constraints may result in a biased simulation of species distribution. More importantly, the influence of climate and land-use changes on species distribution varied between SDMT and SDMWT, which is consistent with the findings of earlier studies on endangered plants [20]. Compared with the results of SDMWT, SDMT showed that *Syrmaticus reevesii* would lose more of its original habitat under three environmental change scenarios. From the above findings, we highlight that topography will govern the response of endangered birds to climate and land-use changes.

4.4. National Nature Reserve Networks Effectively Decrease the Extinction Risk of *Syrmaticus reevesii* under Climate and Land-Use Changes

Nature reserves play an important role in habitat conservation for wild endangered species [54,55]. However, the effectiveness of nature reserves in safeguarding endangered species largely depends on the proportion of the distribution range for threatened species encompassed by these nature reserves [16,54,55]. In our study, on average, less than 15% of the suitable habitat area of *Syrmaticus reevesii* was covered by the National Nature Reserve Network of China (NNR). Our results further demonstrated that the area decrease ratio of *Syrmaticus reevesii* was significantly lower inside than outside the NNR under climate and land-use changes. Inside the NNR, *Syrmaticus reevesii* were predicted to lose 21.64% (for SDMWT) and 37.05% (for SDMT) of their current ranges, on average. In contrast, outside the NNR, *Syrmaticus reevesii* were predicted to lose more than 50% of their current distribution space on average (62.97% for SDMWT and 72.60% for SDMT). These results indicate that NNRs can effectively decrease the extinction risk of *Syrmaticus reevesii* under climate and land-use changes. A previous study indicated that a high portion of refugia habitats are found within existing protected areas, with NNRs being one important type of protected area [56]. Therefore, NNRs could serve as potential refugia for *Syrmaticus reevesii* under climate and land-use changes [57], and reduce the negative impact of climate and land-use changes on *Syrmaticus reevesii*. Meanwhile, climate and land-use changes will cause *Syrmaticus reevesii* to lose most of its original habitat. These findings suggest that it is urgent to increase and expand the nature reserve networks in China [16,58]. Additionally, given their very limited capacity for long-distance dispersal, *Syrmaticus reevesii* may face a high extinction risk in the future. Therefore, other conservation strategies, such as ex situ conservation, should be carried out. Taken together, future conservation management for threatened birds should take into account the potential impact of climate and land-use changes under topographical constraints. Therefore, rapidly reducing global emissions of greenhouse gases is ultimately the best solution to the impacts of climate change on threatened species like *Syrmaticus reevesii*. Furthermore, it is also essential to adjust and develop nature reserve networks and conservation strategies to cope with rapid global environmental change.

5. Conclusions

This study represents an attempt to comprehensively examine the potential influence of climate and land use change on threatened forest resident bird under topographical constraint. Our results found that the climate and land use change will significantly alter the suitable distribution range of endangered Phasianidae species, where climate change will play a dominant role. The suitable distribution areas of *Syrmaticus reevesii* would significantly decrease in facing climate and land use change expected in 2070 from the three scenarios evaluated, and this species may face a significant risk of extinction in 2070. More importantly, the area change predicted by climate and land-use changes would be significantly lower inside the China Nature Reserve Network (NNR) than outside the NNR. However, less than 15% of the area suitable for *Syrmaticus reevesii* has been covered by NNR. In addition, topographical factors will mediate the response of *Syrmaticus reevesii* to climate and land-use changes. These findings indicate that it is imperative to adjust and develop nature reserve networks and conservation strategies to cope with rapid global environmental change. Future conservation management for threatened bird should take into the potential impact of climate and land use change.

Supplementary Materials: The following supporting information can be downloaded at: <https://www.mdpi.com/article/10.3390/f15020348/s1>. Table S1. Transect information in seven province. Figure S1. Cluster analysis of the environmental variables. Figure S2. Presence probability distribution maps for *Syrmaticus reevesii* under current and future (RCP 2.6, RCP 4.5, and RCP 8.5 in 2070) environmental conditions, simulated by SDMWT (without the constraints of topography). Figure S3. Presence probability distribution maps for *Syrmaticus reevesii* under current and future (RCP 2.6, RCP 4.5, and RCP 8.5 in 2070) environmental conditions, simulated by SDMT (with the constraints of topography).

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Data Availability Statement: The data will be made available by the authors on request.

Conflicts of Interest: The authors declare no competing interests.

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