

**Revision of manuscript “Calibration of FARSITE Fire Area Simulator in Iranian Northern Forests”**

**I) General comments**

This is a very interesting paper focusing on a topic, which is undoubtedly highly relevant.

The manuscript is generally well structured and correctly written. However, some parts are a little bit vague, confusing, or even incorrect, and should be rewritten.

Throughout the manuscript, many aspects need to be further explained and many decisions or assumptions have to be further justified.

The methodological approach that was implemented is generally correct, although its explanation is not always clear enough. Moreover, some aspects of the calibration process could probably be improved exploring some complementary approaches.

Some methodological aspects are too ambiguous and need to be better explained. In particular, the section devoted to **Fuel mapping and fuel model assignments** is often ambiguous. The authors have to explain PRECISELY their field sampling work and which vegetation data they collected. They have to show the quantitative values of the vegetation variables that they sampled and explain how they used the vegetation data (either collected on the field, or from the bibliography) for updating the available land cover maps and deriving suitable fuel model maps.

Some methodological choices are not sufficiently justified and this lack of explanations makes some of the decisions or approaches seem a little bit daring or even risky, sometimes.

The discussion is rather poor and has to be improved.

In synthesis, I would support the publication of this paper, if some major revisions are correctly performed.

All the aspects that need to be further explained or completed are explained in detail below.

**II) Specific comments**

**Introduction**

**-Page 2, lines 34- 35:** This first sentence is too vague and those “*losses*” are not enough explained. The text should be more precise.

**-Page 2, line 36:** Your reference (i.e. *FAO, 2005*) is rather old. Can you find something more recent?

**-Page 2, line 37:** It would be interesting to know how much this 7% represents over the total area of Northern Iranian mountains.

**-Page 2, line 42:** If all the species you cite do not fit in ALL categories (i.e. protected, endangered and endemic animals), you should replace “and” by “or”.

**-Page 3, line 43-50:** In my opinion, this paragraph is too long.

**-Page 3, line 58 and line 61:** Other references should be cited.

**-Page 4, line 87:** The concept of “*fuel model*” (and of “*surface fuel models*”, in particular) should be briefly explained.

**-Page 4, line 88:** The sentence is not correctly expressed. The maps do not “*derive*” from GIS, or from remote sensing. A GIS is rather used to prepare (or adapt) the required spatial information.

Besides, canopy-related data may be provided to FARSITE as constants and are not required as spatial inputs.

**-Page 5, line 90:** What does “*quality*” mean exactly here? You need to be more precise.

**-Page 5, line 91:** “*Although data availability increased during the recent years, ...*” Where? Everywhere? Also in your areas?

**-Page 5, line 94:** “*...mapped vegetation attributes*”. Are you sure that “*attributes*” is the suitable word here?

**-Page 5, line 94:** “*In the last years...*” seems unsuitable here, since you cite Anderson (1982), published 32 years ago!

**-Page 5, line 98:** “*.... local vegetation complexes or fuel types properties*”. What do you mean exactly? It is not clear enough. Be more precise.

**-Page 5, line 102:** “*We tested different standard fuel models...*”. The text is a little bit confusing. You don’t explain clearly if you intend to compare these 2 sets of standard fuel models, or rather to compare pairs of standard fuel models (mixing both sets).

**-Page 5, lines 107-108:** The last sentence of this paragraph is written as if it was a part of your discussion or conclusions. It should be rewritten.

**-Page 5, line 108:** “*... for several fire management purposes*”. It is too vague.

## **Materials and Methods**

### **Study area**

**-Page 6, lines 117-130:** You should indicate the altitude range of the Siahkal forest area as well as the average annual temperature and maximum temperature.

**-Page 7, lines 139-142:** You have to indicate the most representative and abundant species of each vegetation type you cite.

### **Wildfire history**

**-Page 7, line 145:** Is this average annual area burned? Be more precise.

**-Page 7, lines 145-147:** But Figure 2 that you cite shows the figures for your 2 study areas and you were speaking about “northern Iran” in the previous sentence? It is confusing.

Be more precise in relation to the area(s) that you comment all through this paragraph (lines 144-153).

**-Page 7, line 148:** A reference should be cited after “...*fuel accumulation*”.

**-Page 7, line 149:** Which “*area*” are you referring to? Be more precise in relation to the area(s) that you comment all through this paragraph (lines 144-153).

**-Page 8, line 157:** Do you mean “average annual area burned”? Be more precise. It would be interesting to know which percentage of that study area is burned each year (the average value).

**-Page 8, line 161:** Do you mean “average annual area burned”? Be more precise. It would be interesting to know which percentage of that study area is burned each year (the average value).

### **Case studies**

**-Page 8, line 166:** How many FARSITE simulations did you perform for each experimental case? This is not explicitly said in the Methods, although it seems (based on Figure 7) that you only performed one. Is it correct? Do you think that it is a trustworthy approach? In any case, you have to explain and justify any methodological decision.

**-Page 8, line 170:** You cite Table 1, but it does not show any quantitative value for any structural characteristic of the vegetation types that are present in your sites. Have you gathered this type of data? You need to describe quantitatively (based on field samplings and/or bibliography) a set of structural variables among those that are usually used in the literature for describing plant communities as fuel models. Without quantitative data, it is not possible to reasonably and accurately perform the reclassification of vegetation types into standard fuel models. **Those aspects need to be further and better explained in your manuscript.** You need to provide more data (complete Table 1) and give more detailed explanations about your vegetation sampling work.

**-Page 8, line 171:** When was this “*survey fieldwork*” carried out precisely?

**-Page 8, line 171:** “...*determined by .....Global Positioning System (GPS) data*”. What do you mean exactly?

**-Page 10, lines 211-212:** “*The fire spread towards north-east driven by moderate south-east winds.*” Is this correct? It seems more logical that winds are from South-west if fire spreads towards North-east.

### **Fuel mapping and fuel model assignments**

In this section, you need to provide more detailed information about your vegetation sampling work (experimental design in detail, dates, detailed list of sampled variables, etc.), but also about the methodology that you applied for combining the vegetation data with the available cartography and the bibliographic information in order to produce suitable and updated fuel model maps. **This is not clear at all. This section is too ambiguous and needs to be completed and improved.**

**-Page 10, lines 215-216:** “...*intensive field sampling and measurements on the main plant communities of the study areas*, This part of the sentence is too vague and imprecise. It should be rewritten.

**-Page 10, lines 216-217:** “... “*in combination with the 1:25,000 land-cover maps*”. What do you mean exactly with “*in combination*”? You have to explain precisely how you used your field data for updating the available maps.

**-Page 10, line 217:** “...*the 1:25,000 land-cover maps*”. We need more information about those maps. We need to know, in particular, when were they produced in each site (not the publication dates, BUT THE field work years). If those maps were produced several years before (or after) the reference fires of your sites (occurred in 2010 and 2011), those maps may be completely unsuitable for your purposes. You should comment all those matters in detail in this section and justify any decision you may have taken due to a limited availability of vegetation (or land cover) maps.

**-Page 10, line 221:** “*surface fuel model parameters*“. Which ones?? Be precise!

**-Page 10, lines 221-222:** “*canopy characteristics*“. Which ones?? Be precise!

**-Page 11, lines 223-225:** How many plots were sampled per vegetation type? Why? How did you decide their location? Many aspects of your methodological approaches need to be clarified.

**-Page 11, line 226:** “*structural stage*”. What do you mean? Be more precise.

**-Page 11, lines 225-229:** I find no variables related to either vegetation covers, or aboveground biomasses....?? How did you get, for instance, the information about the different fuel loads for your various vegetation types?

**-Page 11, line 230:** “*The experiences of fire engineers...*”. What do you mean exactly?

**-Page 11, lines 229-232:** It is very ambiguous. It is not clear AT ALL how this “*reinterpretation of the initial vegetation maps*” that you mention was carried out. You have to clarify your methodological approaches explaining in detail the different stages of the process.

**-Page 11, lines 233-235:** But, apparently, you have not gathered all the required vegetation variables for correctly achieving that. At least, the information does not appear in your manuscript.

**-Page 11 and 12, lines 236-251:** This paragraph should be included in the Results section rather than here. Besides, the reclassification of vegetation types into standard fuel models that is proposed should be presented in a Table also. It would be much more understandable and clear.

**-Page 12, lines 253-255:** As commented before (*Page 4, line 88*), three of the canopy-related variables (i.e. stand height, crown base height, crown bulk density) ARE NOT REQUIRED by FARSITE in a spatial format. They can be provided as constants and they are often provided in such format due to the GREAT difficulty of obtaining accurate maps for those variables. How did you derive those maps for your study sites based on the rather poor available information?

**-Page 12, line 257:** What is the spatial resolution of that DEM?

**-Page 12, lines 258-259:** It was not accurately explained (see previous comments about page 11).

**-Page 12, lines 263-266:** You should provide more information about the steps you followed for applying in your sites the Rothermel's method that you are citing.

Moreover, you have to provide in your Annexes the tables corresponding to the FM calculations worksheets (*sensu* Rothermel, 1983) that you generated in order to obtain the fine dead FMCs.

You carried out field work on your study sites. Why did you not gather any fuel moisture data? Did you have any data available in the literature for your species and/or areas? In any case, you need to comment all the limitations of your work in your text.

**-Page 13, lines 267-268:** In relation to live fuel moisture contents, you are citing authors that worked in the Mediterranean basin in various areas characterized by species, which are very different from those you cite for your study sites. The climatic conditions are of course very different too.

Do you think that those data provided for the Mediterranean region can be reasonably used in your sites? If you do, you should justify this decision as well as all the decisions that you have taken in your work.

### **FARSITE simulations**

**-Page 13, line 270:** As previously commented (*Page 8, line 166*), you need to say explicitly how many FARSITE simulations have you performed for each experimental case.

**-Page 13, lines 270-274:** As previously commented (*Page 5, line 102*), you need to better explain your approach and objectives. The text "*...using different combinations of standard fuel models*" is rather ambiguous.

**-Page 13, lines 273-274:** The text can be improved. You are rather assessing the influence of fuel models on the accuracy of the projections of fire spread and behavior.

**-Page 13, line 275:** Why the adjustment factors have always been maintained at 1.0? Did you try other values for some simulations and fuel models? If not, please justify why.

It is an obvious and meaningful way of trying to improve the spatial agreement between modeled and real fires. Based on what we can see in Table 5 and Figure 7, it seems that it is interesting to apply it in some of your case studies, particularly in YekeBermagh. Explore that possibility and complete your results with the new simulations.

**-Page 14, lines 290-291:** “...is an indicator of the exclusive association between observed and simulated burned areas”. If you express it that way, it seems that the Sorensen’s coefficient was designed and is only used for that purpose, and it is not true.

### **Statistical analysis**

**-Page 13, line 285:** But Table 5 only shows the “best” simulations! Your text does not correspond, thus, to what is presented in the table. You should either modify it, or present all the results in another table.

### **Discussion**

This section needs to be completed. Several important aspects of the calibration process and some limitations of your work have to be further commented.

Scale issues are not mentioned and should also appear in the discussion. You have to mention at some point that FARSITE is a fire model operating at a local (i.e. landscape) scale (other available models were designed for broader scales), which implies some benefits, but also some requirements and limitations.

**-Page 18, line 385:** “*Verification..*”. What do you mean exactly? Cite other studies having done this.

**-Page 18, line 390:** Shouldn’t it be “calibration and validation” rather than “*validation and calibration*”?

**-Page 18, lines 392-394:** You do not comment anything specific about wind data. You should insist on that source of error. As you know, wind data are crucial for fire modeling and in most studies good local wind data are not available.

In your study, this issue is not sufficiently discussed. Besides, it is not clear if the wind data provided by the 2 weather stations (data presented in Table 2) are reliable or not. You mention in Table 2 the distance between the weather stations and your sites, but, we do not have enough information about the fine-scale topographic situation of those weather stations and about their dominant winds and if, in each of those 2 stations, the dominant winds have the same characteristics as those prevailing in the study areas. A weather station can be very close to a given area, but still characterized by different dominant wind directions, for instance.

You have to provide more information and discuss explicitly about all those matters.

**-Page 19, line 403:** “...can accurately replicate fire perimeters ***and behavior*** in our study areas.” Do you know precisely what was the spatial distribution of fire behavior variables in the real fires that you have chosen? If you do, you should have commented those data. If you don’t, you can’t say that, or at least you can’t say that in that way, and you have to change this sentence in your text.

**-Page 19, line 408:** “...and fire behavior”. See my previous comment.

**-Page 19, lines 403-407:** “*In this work, the main fuel model types and characteristics were initially identified by classifying the vegetation structures combining field sampling data and bibliographic information (Anderson, 1982; Scott 405 and Burgan, 2005). Then, we associated each fuel type to a specific standard fuel model to simulate fire propagation and behavior with FARSITE (Finney, 1998).*”

This text has to be in the Methods section.

**-Page 19, lines 410-414:** “*The good agreement between the actual and simulated fire perimeters, as measured by SC and K coefficients, resulted in values higher than 0.69 for SC and 0.68 for K, considering all case studies and the most accurate FARSITE simulations. In more detail, the best FARSITE simulations ranged from 0.69 to 0.86, in terms of SC, and from 0.68 to 0.82, in terms of K (Table 4).*”

This text has to be in the Results section. This is not a discussion.

**-Page 20, line 426:** “*...which have high load and height*”. Have you got this information for the plant communities of your study sites? In the paper I could not find any quantitative data about those crucial variables. As commented previously (Page 8, line 170), quantitative data about a set of structural variables are required to classify your vegetation types as standard fuel models, but that information does not appear in your paper.

It is not clear if you gathered it on the field (completing it maybe with data found in the bibliography) or if you did not gather it at all. Clarify those aspects please.

**-Page 20, line 428:** The text mentions “*fire intensity levels*”, but FML refers to flame length. Revise and correct.

## Conclusions

**-Page 20, line 437:** “*on fine scale FARSITE outputs*“. What do you mean exactly? Clarify.

**-Page 20, line 439:** “*...wide variation*“. Again, the precise meaning of your text is not clear. It seems, that you have not described nor analyzed properly this “variability” in your Results section.

**-Page 20, line 441:** We don’t know if your affirmation is correct, because you did not explain properly those “*...local vegetation conditions*”. (see comments Page 8, line 170 and Page 20, line 426)

**-Page 21, line 441:** It is probably better to say “defined and mapped” instead of “*mapped and defined*”

**-Pages 21-22, lines 441-442:** “*...which were mapped and defined combining field sampling activities and 1:25.000 land use maps*”. As previously commented (Page 10, line 217), this part of the work is rather obscure and has to be further explained.

Besides, we need to know which are the dates of those land use maps (for each study site). More precisely, when were carried out the field work campaigns (in each study site) during the preparation of those maps?

We need to know that in order to know if those maps were updated and appropriate for deriving the fuel model maps and simulating fires of years 2010 and 2011.

**-Page 22, line 442:** “*land use maps*” were previously named “*land cover maps*”. It creates confusion. Moreover, it is not necessarily exactly the same. You should choose one unique name and keep it.

**-Page 21, line 445:** “...*a high potential for estimating spatial variability in fire spread and behavior in the study areas.*” In relation to the fire behavior, as commented previously (Page 19, line 403), are you sure that you have showed that? We can’t infer that based on the results you have explained in your manuscript.

**-Page 21, lines 452-454:** I think those comments should be developed in the Discussion section. You have to further comment the limitations that you faced in your study sites in relation to the available vegetation/land cover cartography (accuracy, dates...), but ALSO the limitations of your field work. Then, you can honestly discuss the difficulties for carrying out a suitable reclassification of the vegetation types in standard fuel models.

**-Page 21, lines 453-454:** But ALSO for improving the reclassification of vegetation types in standard fuel models.

### References

**-Page 29, lines 629-631:** The indicated date is not correct.

**-Page 29, lines 632-636:** The reference is not complete.

### III) Technical corrections

**-Page 2, line 38-39:** “*as well as*” should be replaced by “as it happens in other areas”

**-Page 2, line 40:** “*The North Iran...*” should be replaced by “The Northern Iran..”

**-Page 2, line 42:** If all the species you cite do not fit in ALL categories (i.e. protected, endangered and endemic animals), you should replace “*and*” by “or”.

**-Page 4, line 70:** “*The simulator is a semi-empirical...*” should be replaced by “The simulator, **which** is a semi-empirical...”.

**-Page 4, lines 77-80:** The second part of the sentence beginning with “*However, the use...*” (i.e. “...*and corresponds to the primary step to then apply the simulator at larger scales*” ) does not fit with the first part. The whole sentence should be rewritten or this second part separated in another sentence.

**-Page 5, line 89:** “The outputs...” instead of “...: *the outputs...*”

**-Page 5, line 91:**

“during recent years” instead of “*during the recent years, ...*”

**-Page 5, line 92:** “...*fuel maps still result difficult to be generated and updated...*”



This part of the sentence is not correctly written. A possible text would be : “, it is still very difficult to generate and update reliable fuel model maps in many regions...”

**-Page 5, line 93:** “..fuel model cartography” instead of “..*geospatial fuel model cartography*”. As you say “*cartography*”, “*geospatial*” is redundant.

**-Page 5, line 93:** “..fuel model cartography” instead of “..*geospatial fuel model cartography*”. As you say “*cartography*”, “*geospatial*” is redundant.

**-Page 5, line 93:** “suitable” instead of “*employable*”

**-Page 5, line 101:** “...replicating historical wildfire spread..” instead of “...*replicating wildfire spread..*”

**-Page 7, line 138:** The “park” instead of “*Park*”.

**-Page 8, line 168:** “Specific” instead of “*Species*”.

**-Page 10, line 215:** “based on..” instead of “*by..*”

**-Page 11, line 225:** “the” instead of “*to*”

**-Page 11, lines 233-234:** “vegetation structural characteristics” instead of “*vegetations structure characteristics*”

**-Page 13, line 272:** The citation of Table 5 is not appropriate here.

**-Page 14, line 288:** ”spatial accuracy” instead of “*accuracy*“

**-Page 14, line 288:** “simulated fire spread” instead of “*fire spread*“

**-Page 14, line 304:** ”spatial agreement” instead of “*agreement*“

**-Page 17, line 366:** ”The shrublands showed a rate...” instead of “; *the shrublands showed rate...* “

**-Page 17, line 370:** ”This explains...” instead of “; *this explains...*”. Besides, this sentence is not correctly written.

**-Page 17, line 372:** ”As well as for the rate of...” instead of “*As well as rate of ...*“.

**-Page 17, line 372:** “ ...intensity were identified between grasslands...” instead of “*intensity between grasslands ...*” ...“.

**-Page 17, line 373:** “....other vegetation types.” instead of “*vegetations were identified*”.

**-Page 18, line 383:** “... the expected behavior of hypothetical fires...” instead of “*the expected fire behavior and...* “

**-Page 18, lines 383-384:** “...and play a key role in proactive decision-making to take decisions before the fire front arrival” . This second part of the sentence is not well written and should be improved.

**-Page 18, line 385:** “adoption and application in a given landscape should... ” instead of “*adoption and application should...*”.

**-Page 18, lines 392-394:** “These sources may include an insufficient accuracy of...” instead of “*These include the accuracy of...*”

**-Page 18, lines 392-393:** “...bias in weather station locations compared to where the fire is burning...”. This part of the sentence is not correct. Rewrite.

**-Page 18, line 393:** “mapping of fire perimeters” instead of “*mapping of fire perimeter locations*”

**-Page 18, line 394:** “... errors from the user who runs the models”. This is not precise enough.

**-Page 19, line 403:** “replicate real fire perimeters” instead of “*replicate fire perimeters*”

**-Page 19, line 410:** “spatial agreement” instead of “*agreement*”

**-Page 20, line 424:** I think you mean “and in agreement with...” instead of “*and according to..*”. Revise and correct if necessary.

**-Page 20, line 428:** “Such...” instead of “: *such...*”.

**-Page 21, lines 445-446:** “This work represents a first step in the promotion of fire modeling....” instead of “*This work could represents a first step for the applications of fire spread modeling...*”

**-Page 21, line 448:** “...due to the limited availability of data about local fuels and fires..” instead of “...*the local fuels and fire data available....*”.

**-Page 21, lines 446-449:** “*Quantifying ....is needed.*” The whole sentence sounds weird. You should rewrite it.

**-Page 21, line 450:** Do you mean in “...other study areas” rather than “*the study areas*”?

**-Page 21, lines 452-454:** The sentence is not very correct and should be rewritten.

**-Page 21, line 454:** You could add “more precise” before “*photo-guides...*”.

### **Tables:**

As previously commented, a new Table should be added showing the reclassification of vegetation types into standard fuel models that you have proposed.

**Table 1:** It is incomplete. We need to know which are the vegetation structural variables that were sampled and the quantitative values obtained.

**Figures:**

**Figure 3:** Do you mean “Monthly **mean** fire number and burned area”?

**Figure 4:** It would be interesting to also know the evolution of this relationship across the studied period.

**Figure 5:** You have to comment when were those vegetation maps produced in each site.

The colours that have been chosen for representing some of the different vegetation types are too similar and make the maps difficult to interpret.

**Figure 6:** The various standard fuel models that you have proposed for each fuel type have to be indicated.

**Figure 7:** “grey” instead of “gray”.

It seems that only one FARSITE simulation was performed for each experimental case. Is it right? Do you consider that it is reliable enough? Justify. As commented previously, this is never explained in the Methods.