Peer Community In Ecology

Preventing misuse of high-resolution remote sensing data

Eric Goberville *based on peer reviews by* ***Jane Wyngaard*** *and 1 anonymous reviewer*

Adam L. Mahood, Maxwell Benjamin Joseph, Anna Spiers, Michael J. Koontz, Nayani Ilangakoon, Kylen Solvik, Nathan Quarderer, Joe McGlinchy, Victoria Scholl, Lise St. Denis, Chelsea Nagy, Anna Braswell, Matthew W. Rossi, Lauren Herwehe, Leah wasser, Megan Elizabeth Cattau, Virginia Iglesias, Fangfang Yao, Stefan Leyk, Jennifer Balch (2022) Ten simple rules for working with high resolution remote sensing data. OSF, ver. 6, peer-reviewed and recommended by Peer Community in Ecology.
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To observe, characterise, identify, understand, predict... This is the approach that researchers follow every day. This sequence is tirelessly repeated as the biological model, the targeted ecosystem and/or the experimental, environmental or modelling conditions change. This way of proceeding is essential in a world of rapid change in response to the frenetic pace of intensifying pressures and forcings that impact ecosystems. To better understand our Earth and the dynamics of its components, to map ecosystems and diversity patterns, and to identify changes, humanity had to demonstrate inventiveness and defy gravity.

Gustave Hermite and Georges Besançon were the first to launch aloft balloons equipped with radio transmitters, making possible the transmission of meteorological data to observers in real time [1]. The development of aviation in the middle of the 20th century constituted a real leap forward for the frequent acquisition of aerial observations, leading to a significant improvement in weather forecasting models. The need for systematic collection of data as holistic as possible – an essential component for the observation of complex biological systems - has resulted in pushing the limits of technological prowess.

The conquest of space and the concurrent development of satellite observations has largely contributed to the collection of a considerable mass of data, placing our Earth under the "macroscope" - a concept introduced to ecology in the early 1970s by Howard T. Odum (see [2]), and therefore allowing researchers to move towards a better understanding of ecological systems, deterministic and stochastic patterns ... with the ultimate goal of improving management actions [2,3]. Satellite observations have been carried out for nearly five decades now

[3] and have greatly contributed to a better qualitative and quantitative understanding of the functioning of our planet, its diversity, its climate… and to a better anticipation of possible future changes (e.g., [4-7]).

This access to rich and complex sources of information, for which both spatial and temporal resolutions are increasingly fine, results in the implementation of increasingly complex computation-based analyses, in order to meet the need for a better understanding of ecological mechanisms and processes, and their possible changes. Steven Levitt stated that "*Data is one of the most powerful mechanisms for telling stories*". This is so true … Data should not be used as a guide to thinking and a critical judgment at each stage of the data exploitation process should not be neglected.

This is what Mahood et al. [8] rightly remind us in their article "*Ten simple rules for working with high-resolution remote sensing data*" in which they provide the fundamentals to consider when working with data of this nature, a still underutilized resource in several topics, such as conservation biology [3]. In this unconventional article, presented in a pedagogical way, the authors remind different generations of readers how satellite data should be handled and processed. The authors aim to make the readers aware of the most frequent pitfalls encouraging them to use data adapted to their original question, the most suitable tools/methods/procedures, to avoid methodological overkill, and to ensure both ethical use of data and transparency in the research process. While access to high-resolution data is increasingly easy thanks to the implementation of dedicated platforms [4], and because of the development of easy-to-use processing software and pipelines, it is important to take the time to recall some of the essential rules and guidelines for managing them, from new users with little or no experience who will find in this article the recommendations, resources and advice necessary to start exploiting remote sensing data, to more experienced researchers.

References:

[1] Jeannet P, Philipona R, and Richner H (2016). 8 Swiss upper-air balloon soundings since 1902. In: Willemse S, Furger M (2016) From weather observations to atmospheric and climate sciences in Switzerland: Celebrating 100 years of the Swiss Society for Meteorology. vdf Hochschulverlag AG.

[2] Odum HT (2007) Environment, Power, and Society for the Twenty-First Century: The Hierarchy of Energy. Columbia University Press.

[3] Boyle SA, Kennedy CM, Torres J, Colman K, Pérez-Estigarribia PE, Sancha NU de la (2014) High-Resolution Satellite Imagery Is an Important yet Underutilized Resource in Conservation Biology. PLOS ONE, 9, e86908. https://doi.org/10.1371/journal.pone.0086908

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[7] Zhao Q, Yu L, Du Z, Peng D, Hao P, Zhang Y, Gong P (2022) An Overview of the Applications of Earth Observation Satellite Data: Impacts and Future Trends. Remote Sensing, 14, 1863. https://doi.org/10.3390/rs14081863

[8] Mahood AL, Joseph MB, Spiers A, Koontz MJ, Ilangakoon N, Solvik K, Quarderer N, McGlinchy J, Scholl V, Denis LS, Nagy C, Braswell A, Rossi MW, Herwehe L, Wasser L, Cattau ME, Iglesias V, Yao F, Leyk S, Balch J (2021) Ten simple rules for working with high resolution remote sensing data. OSFpreprints, ver. 6 peer-reviewed and recommended by Peer Community in Ecology. https://doi.org/10.31219/osf.io/kehqz

Reviews

Evaluation round #2

DOI or URL of the preprint: https://doi.org/10.31219/osf.io/kehqz
Version of the preprint: 3

Authors' reply, 15 September 2022

Dear Dr. Goberville,

We are pleased to resubmit our paper "Ten simple rules for working with high resolution remote sensing data." We appreciated the suggestions by you and reviewer #2, and worked hard to address them. In particular, we edited the text throughout for greater clarity, and we added 3 tables to help the reader get a sense of the data sources, tools and resources available. Finally, we added a scaling figure.

Thank you,

Adam Mahood

Editor: Decision on Manuscript "Ten simple rules for working with high resolution remote sensing data"

1) The authors mention several data sources. As the paper is oriented towards a pedagogical approach, a summary table of some of the datasets or data sources, with the access links, could be helpful.

Authors: This is now Table 1

2) The use of bulleted lists could help to better identify author's guidance, for example at the end of the paragraph "Know the question".

Authors: We appreciate the suggestion, but ended up sticking with the current paragraph structure in the text.

3) I would suggest to be more specific in several parts of the manuscript. For example, on the concept of fitness (see "Understand the data"): some sentences are too vague: how to ensure data quality? how to evaluate the adequacy between data and the question? While the advice is important, it may also be necessary to provide ways to meet this expectation if tools exist.

Authors: We added more information to the fitness paragraph in the "Understand the data" section - including some citations that are examples of exploring fitness.

4) I do not know if the authors can do such an exercise, but I would suggest to add a table –or, even better, a figure to highlight the link between spatial resolutions and phenomena depending on the spatial scale to consider in a given context, while displaying possible overlaps (such as proposed in Schlünzen et al; doi: 10.1016/j.jweia.2011.01.009).

Authors: We created Figure 2 and refer to it on line 41.

5) In the same idea, i.e., to guide the readers in the best possible way, I would suggest to make a list of software for people who would like to start processing and/or visualizing remote sensing data; or to provide books, references, tutorials to readers to help them get started, e.g., resources identify by the authors of which they appreciate the quality, for both the construction of the analyses and/or the clarity of the approaches. The remark also applies for the section "Show your work".

Authors: We have added a list of resources as tables 2 and 3.

6) Section 9 “Do no harm” is sometimes unclear, especially the part dedicated to ethics. Broadly speaking, I would suggest to clarify some of the sections of the manuscript. For some sections, the first sentences are describing some concepts, gaps, limitations, issues... and examples are shown after, often in a second paragraph. To clarify the key messages, and especially because of the targeted audience of the paper, I would suggest to integrate the examples directly when the issues are raised.

Authors: We edited several sections for increased clarity.

7) Section 9 “Do no harm”. If applicable, I would suggest to add directly in the paper the corresponding url to redirect the readers toward the guidelines (Section 9). This will allow the readers to better find the information for adopting good practices

Authors: We have added the URL for this and other resources to table 2.

Reviewer 1

Reviewed by anonymous reviewer, 26 Apr 2022 12:14

The authors have addressed all my comments. I look forward to seeing this manuscript officially published.

Authors: Thank you!

Reviewer 2

Reviewed by Jane Wyngaard, 23 May 2022 10:41

Great updates, good examples, more detailed discussion of some of the technical points, more detailed coverage of aspects of processing high res imagery rather than general research techniques although some aspects remain true of any research (specifically rules 1, 2, 4, 8).

It’s for the editors to determine if the content is in line with the journal’s vision. The core content is relevant and useful to a new postgraduate student or undergrad research assistant and will be of great use to them but is not reporting anything novel or revolutionary nor is the collation of ’rules’/’tips’ particularly rare.

In terms of the technical content the only points I would suggest adding would be:

1. With regards to rule 9 ”Do no harm”. In addition to the high level organisational guides discussed a new researcher would do well to seek out data management codes of practice specific to their domain and/or specific to the data set being investigated/collected. In most cases multiple codes of conduct, legal requirements, and community and institutional guidelines will be applicable. It is the responsibility of the researcher to throughly explore what these are with relation to their data and to get clearance to investigate and publish their research. For Example:

https://werobotics.org/codeofconduct/

http://trust-project.eu/wp-content/uploads/2017/03/San-Code-of-RESEARCH-Ethics-Booklet-final.pdf

Authors: We added those resources in what is now table 2, and added the following text to lines 400-405:

“Responsible use of data, that is, the duty to respect people’s rights, sensitivities, and security over data, and to implement values of transparency and openness, requires ethical and analytical considerations. Community and institutional guidelines, codes of conduct, and legal requirements specific to datasets being collected or analyzed are frequently in place and can help guide the responsible use of information. It is the responsibility of the researcher to understand and comply with these guidelines.”

2. With regards to rule 10 ”Show your work” and 6 ”Survey the computing and software landscape”. While this is still an evolving space, it would be ideal if the authors could point readers to practical resources specific to high res remote sensing data such as perhaps pointing to the following and discussing specific examples:

https://data.agu.org/resources/

https://www.rd-alliance.org/recommendations-and-outputs/catalogue

Authors: We added those resources and others to the new tables 2-3.

Decision by Eric Goberville, posted 05 July 2022

Decision on Manuscript "Ten simple rules for working with high resolution remote sensing data"

Dear Dr. Mahood

The revised version of your manuscript entitled 'Ten simple rules for working with high resolution remote sensing data' has now been reviewed.

I would like to thank you both reviewers for their hard work and insights, and the authors for the careful consideration of the previous suggestions. As you will see from the comments, the revised version of your manuscript was positively perceived by both referees, one of whom was fully satisfied with the changes made. The second referee is also convinced by your modifications, and only a few new suggestions have been made.

The format of the paper and its suitability for PCI is discussed, however. After a careful reading of the new version, I confirm that –and although the format is not classical when compared to other articles published by PCI– it has a very good chance of finding its audience and that it may serve as a basis for thoughts on how using remote sensing data. This article could thus be mentioned as a prerequisite to be read by students, but not only; researchers who has to handle this type of data would also be interested. Please find below other comments to consider, in addition to the suggestions made by referee 2.

From my reading, I recommend that the authors pay attention to the few typos still present in the paper, as well as to the punctuation.

1) The authors mention several data sources. As the paper is oriented towards a pedagogical approach, a summary table of some of the datasets or data sources, with the access links, could be helpful.

2) The use of bulleted lists could help to better identify author's guidance, for example at the end of the paragraph "Know the question".

3) I would suggest to be more specific in several parts of the manuscript. For example, on the concept of fitness (see "Understand the data"): some sentences are too vague: how to ensure data quality? how to evaluate the adequacy between data and the question? While the advice is important, it may also be necessary to provide ways to meet this expectation if tools exist.

4) I do not know if the authors can do such an exercise, but I would suggest to add a table –or, even better, a figure to highlight the link between spatial resolutions and phenomena depending on the spatial scale to consider in a given context, while displaying possible overlaps (such as proposed in Schlünzen et al; doi: 10.1016/j.jweia.2011.01.009).

5) In the same idea, i.e., to guide the readers in the best possible way, I would suggest to make a list of software for people who would like to start processing and/or visualizing remote sensing data; or to provide books, references, tutorials to readers to help them get started, e.g., resources identify by the authors of which they appreciate the quality, for both the construction of the analyses and/or the clarity of the approaches. The remark also applies for the section "Show your work".

6) Section 9 "Do no harm" is sometimes unclear, especially the part dedicated to ethics. Broadly speaking, I would suggest to clarify some of the sections of the manuscript. For some sections, the first sentences are describing some concepts, gaps, limitations, issues... and examples are shown after, often in a second paragraph. To clarify the key messages, and especially because of the targeted audience of the paper, I would suggest to integrate the examples directly when the issues are raised.

7) Section 9 "Do no harm". If applicable, I would suggest to add directly in the paper the corresponding url to redirect the readers toward the guidelines (Section 9). This will allow the readers to better find the information for adopting good practices

Please revise the paper according to these two reports and upload a point-by-point response, including a description of any additional materials, and a detailed rebuttal of requested revisions that you disagreed with.

Sincerely yours,

Eric Goberville

Reviewed by anonymous reviewer 1, 26 April 2022

The authors have addressed all my comments. I look forward to seeing this manuscript officially published.

Reviewed by Jane Wyngaard, 23 May 2022

Great updates, good examples, more detailed discussion of some of the technical points, more detailed coverage of aspects of processing high res imagery rather than general research techniques although some aspects remain true of any research (specifically rules 1, 2, 4, 8).

It's for the editors to determine if the content is in line with the journal's vision. The core content is relevant and useful to a new postgraduate student or undergrad research assistant and will be of great use to them but is not reporting anything novel or revolutionary nor is the collation of 'rules'/'tips' particularly rare.

In terms of the technical content the only points I would suggest adding would be:
1. With regards to rule 9 "Do no harm". In addition to the high level organisational guides discussed a new researcher would do well to seek out data management codes of practice specific to their domain and/or specific to the data set being investigated/collected. In most cases multiple codes of conduct, legal requirements, and community and institutional guidelines will be applicable. It is the responsibility of the researcher to throughly explore what these are with relation to their data and to get clearance to investigate and publish their research. For Example:
https://werobotics.org/codeofconduct/
http://trust-project.eu/wp-content/uploads/2017/03/San-Code-of-RESEARCH-Ethics-Booklet-final.pdf

2. With regards to rule 10 "Show your work" and 6 "Survey the computing and software landscape". While this is still an evolving space, it would be ideal if the authors could point readers to practical resources specific to high res remote sensing data such as perhaps pointing to the following and discussing specific examples:
https://data.agu.org/resources/
https://www.rd-alliance.org/recommendations-and-outputs/catalogue

Arguably, however, if the editor is in favour of seeing this article published in this journal it is potentially not worth holding it back for another round of enhancements such as the above points.

Evaluation round #1

DOI or URL of the preprint: https://doi.org/10.31219/osf.io/kehqz
Version of the preprint: 2

Authors' reply, 04 April 2022

Dear PCI Ecology Recommender,

We are pleased to resubmit "Ten simple rules for working with high-resolution remote sensing data". We are grateful to the reviewers who took the time to provide us with thoughtful and constructive feedback to improve

this manuscript. We agreed with and implemented the vast majority of their feedback, and are including here a line by line response to their feedback.

In particular, in this revised version, we overhauled the style of the writing to achieve a more formal tone. We also heavily revised several sections in response to the excellent suggestions by both reviewers, in order to give more specific suggestions, point the reader to specific resources when appropriate, and define important terms such as high-resolution, open source and open science.

We also note that we have changed the order of authors. We feel as though this revised version is greatly improved and suitable for recommendation by PCI Ecology.

Thank you for your reconsideration,

Dr. Adam L. Mahood

Download author's reply

Decision by Eric Goberville, posted 23 January 2022, validated 23 January 2022

Decision on Manuscript "Ten simple rules for working with high resolution remote sensing data"

Dear Dr. Joseph

Your manuscript entitled 'Ten simple rules for working with high resolution remote sensing data' has now been reviewed.

After approaching more than 20 reviewers to review your article (hence the time delay), two have now returned reviews. Thus, I am happy to thank you for your patience, but also draw your attention to the comments made by the reviewers that invite resubmission of the manuscript after consideration of their suggestions. More specifically, it is strongly recommended to refactor the paper to make it more suitable for a peer reviewed journal, including a more extensive literature review. At that point, I will re-engage with the reviewers to ensure that they are happy with the revisions and make a decision regarding the manuscript's future journey with PCI.

Thank you to both reviewers for their hard work and insights.

Sincerely yours,

Eric Goberville

Reviewed by anonymous reviewer 1, 31 December 2021

Here the authors outlined some important considerations when considering using high resolution remote sensing data. This type of data is becoming increasingly accessible and this is a worthwhile thought piece on how to approach this type of data.

I feel this is a very good manuscript. Researchers often default toward "more data is better" and thus are attracted toward high resolution remote sensing imagery. The points outlined here will help them reconsider the practical considerations of using that data, and either reconsider the decision or be better prepared for the process.

I have only minor suggestions, mostly adding useful citations which can help further inform readers. Note I reviewed this version 2 here https://doi.org/10.31219/osf.io/kehqz

Intro: Can you define what you feel high resolution data is currently (maybe just which sensors are considered hi-res in 2021), and how that might change in the future?

L50: “know your question”. This is a great basic rule that researchers should follow for all studies. Recommend citing et al Betts et al 2021, along with Alon 2009, which has some very general points regarding this.

Betts, M.G., Hadley, A.S., Frey, D.W., Frey, S.J., Gannon, D., Harris, S.H., Kim, H., Kormann, U.G., Leimberger, K., Moriarty, K. and Northrup, J.M., 2021. When are hypotheses useful in ecology and evolution?. Ecology and evolution.

Rule 1: This could use some examples of what can go wrong if you don’t focus on an overarching question/ hypothesis. For example, if someone focuses solely on using high resolution data, their analysis may not be able to explain ecological phenomena better than coarse resolution data, since it can be difficult to accurately model the fine resolution variability. (Hallet et al 2004). High resolution data may also have inflated accuracies due to autocorrelation (Ploton et al 2020).

Hallett, T B, T Coulson, J G Pilkington, T H Clutton-Brock, J M Pemberton, and B T Grenfell. 2004. “Why Large-Scale Climate Indices Seem to Predict Ecological Processes Better than Local Weather.” Nature 430 (6995): 71–75. https://doi.org/10.1038/nature02708.

Ploton, Pierre, Frédéric Mortier, Maxime Réjou-Méchain, Nicolas Barbier, Nicolas Picard, Vivien Rossi, Carsten Dormann, et al. 2020. “Spatial Validation Reveals Poor Predictive Performance of Large-Scale Ecological Mapping Models.” Nature Communications 11 (1): 4540. https://doi.org/10.1038/s41467-020-18321-y.

L87: Since this is in PCI Ecology some literature on scaling in ecology would provide great context here. I recommend including the following papers which provide great practical overviews of the topic:

Knegt, H. J. de, F. van Langevelde, M. B. Coughenour, A. K. Skidmore, W. F. de Boer, I.M. A. Heitkönig, N. M. Knox, R. Slotow, C. van der Waal, and H. H. T. Prins. 2010. “Spatial Autocorrelation and the Scaling of Species–Environment Relationships.” Ecology 91 (8): 2455–65. https://doi.org/10.1890/09-1359.1.

Sandel, Brody. 2015. “Towards a Taxonomy of Spatial Scale-Dependence.” Ecography 38 (4): 358–69. https://doi.org/10.1111/ecog.01034.

L101: “knowing your data” should also consider the tradeoffs of high resolution data. Finer spatial scale usually means both a coarser temporal scale (ie. Daily MODIS to 16-day Landsat) and less robust radiometric quality (eg. Planet lab sensors are not as precise as Landsat or Modis, Houborg et al. 2018)

Houborg, Rasmus, and Matthew F. McCabe. 2018. “A Cubesat Enabled Spatio-Temporal Enhancement Method (CESTEM) Utilizing Planet, Landsat and MODIS Data.” Remote Sensing of Environment 209 (May): 211–26. https://doi.org/10.1016/j.rse.2018.02.067.

L101: For how data processing is done you can cite the following guides for UAV and Landsat imagery.

Aasen, Helge, Eija Honkavaara, Arko Lucieer, and Pablo Zarco-Tejada. 2018. “Quantitative Remote Sensing at Ultra-High Resolution with UAV Spectroscopy: A Review of Sensor Technology, Measurement Procedures, and Data Correction Workflows.” Remote Sensing 10 (7): 1091. https://doi.org/10.3390/rs10071091.

Young, N.E., Anderson, R.S., Chignell, S.M., Vorster, A.G., Lawrence, R. and Evangelista, P.H., 2017. A survival guide to Landsat preprocessing. Ecology, 98(4), pp.920-932.

Vong, A., Matos-Carvalho, J.P., Toffanin, P., Pedro, D., Azevedo, F., Moutinho, F., Garcia, N.C., Mora, A., 2021. How to Build a 2D and 3D Aerial Multispectral Map?—All Steps Deeply Explained. Remote Sens. 13, 3227. https://doi.org/10.3390/rs13163227

L115: This seems like a good spot to emphasize the time costs of high-resolution images. For example MODIS data is relatively easy to acquire in an analysis ready form and analysis can be run on most desktop computers. On the other end UAV imagery has a large time cost and requires a user to perform all processing steps from acquisition onward.

L119: Rule #3 is probably the best advice in this manuscript, and I would suggest a more direct statement such as: “Do not use high-resolution unless there is a clear need which justifies the increased cost of acquisition, processing, storing, and analysis”.

L159: bibtex citation issue here for weinsten2020cross

L187: this is something to consider in literally any study and also something emphasized in Betts et al 2021.

L198: A good point to make for #6: investing in training workshops (eg. Data Carpentry) is a worthwhile investment if one is planning to use high resolution imagery, since tools that make their analysis easier generally require scientific programming skills.

Reviewed by **Jane Wyngaard**, 12 January 2022

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