Rammaáætlun 4: Landscape and Wilderness Data Collection Report 2020

David C. Ostman

Háskóli Íslands – Rannsóknasetur á Hornafirði

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Rammaáætlun

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1. Data collection process

The latest landscape and wilderness data collection for Rammaáætlun phase 4 (RÁ4) occurred during the summer of 2020, between July 19th and September 5th. The data collection was targeted and based on the assessment areas of 6 newly-proposed energy priority projects: Alviðra, Vindheimavirkjun, Hamarsvirkjun, Skúfnavatnavirkjun, Tröllárvirkjun, and Hvanneyrardalsvirkjun. Fieldwork was also conducted in the summer of 2019 for 3 additional projects that were known about at the time and have since become formal proposals: Búrfellslundur, Sólheimar, and Vindorkugarður í Garpsdal (Ostman, D. C. & Árnason, Þ., forthcoming). Figure 1 shows the locations of the 9 newly-proposed priority projects for which fieldwork has been conducted over the course of 2019 and 2020.

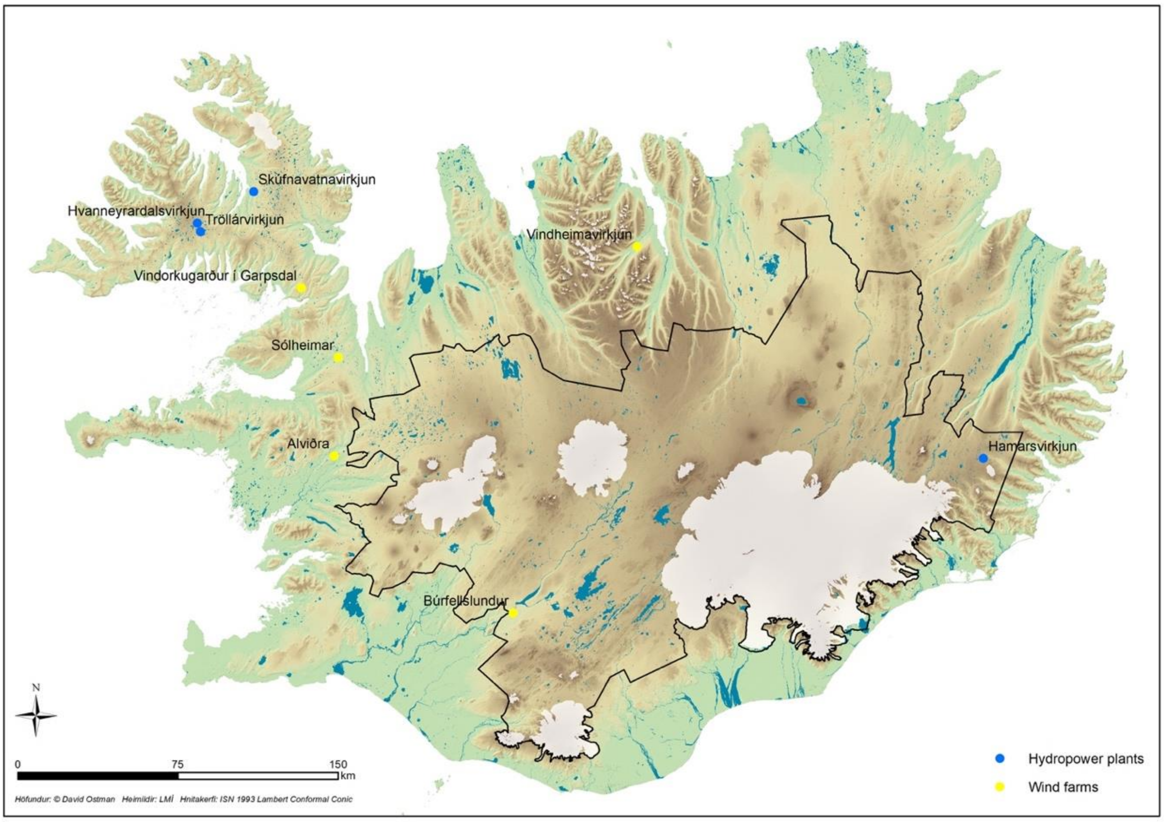


Fig. 1. Locations of proposed priority energy projects for Rammaáætlun phase 4 (RÁ4) for which fieldwork was conducted during the summers of 2019 and 2020

The specific data collection locations for each energy project were dictated by the Icelandic Landscape Project (ILP) methodology, which uses GPS coordinates from a 5 x 5 km point-based grid system (adopted originally from a 10 x 10 km grid from Náttúrufræðistofnun Íslands) and which has been used in previous Rammaáætlun data collection phases (Þórhallsdóttir, Árnason, Bárðarson & Pálsdóttir, 2010). Four types of data were gathered and recorded at each point: (1) Checklist of landscape characteristics (visual features), (2) Checklist of wilderness characteristics (manmade structure-related variables and perceptual qualities), (3) 360-degree photography, and (4) 360-degree videography. Additional photographs and video were taken at data points collected around the wind projects, pointed specifically in the direction of where the proposed turbines would be built. These photos and videos are e.g. intended to be used to create photomontages later in the assessment process (Ostman, D. C. & Árnason, Þ., forthcoming).

A total of 33 individual data points was collected for the 6 project locations visited in the summer of 2020 (in addition, 45 data points were collected in the summer of 2019, 21 of which concern the 3 projects that have become formal proposals in RÁ4). Figure 2 shows the locations of all data points collected - both for priority and non-priority projects - in 2019 and 2020. These newly-collected points will be assessed in combination with all other data points that have already been collected as part of previous ILP fieldwork and Rammaáætlun phases.

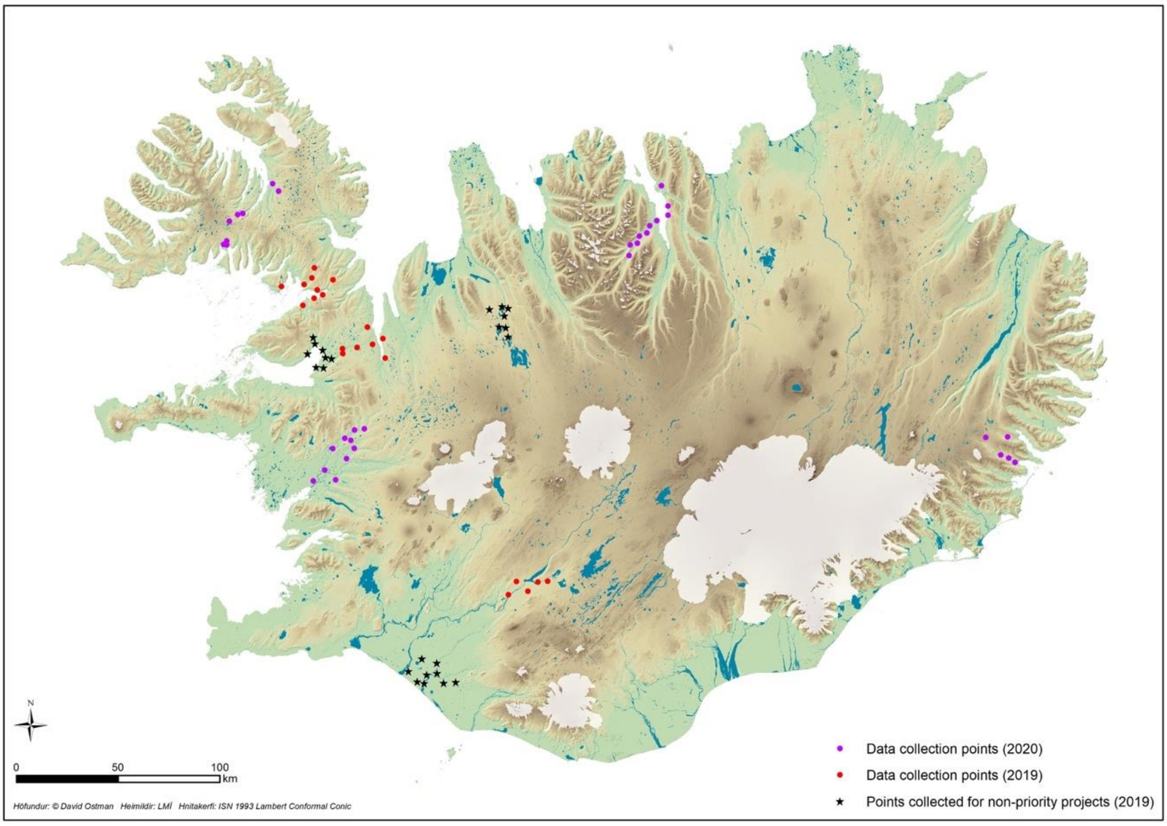


Fig. 2. Fieldwork sampling points collected in the summers of 2019 and 2020 for both priority and non-priority energy projects

Data and analyses concerning proposed windfarm projects will be discussed in more detail in a separate report (Ostman, D. C. & Árnason, Þ., forthcoming).

2. Hydropower projects

2.1 New project proposals

For the 4 new hydropower projects, data points from the 5 x 5 km grid that fell within (or close to) the project impact areas were targeted. Accessibility to the plateau regions and planned catchment areas of these projects proved difficult, so with a couple of exceptions where road and hiking access were possible, most data points were collected in the downstream areas. Figures 3 through 6 show each hydropower project impact area along with the newly-collected data points (and any older points) that will be used in the assessment process.

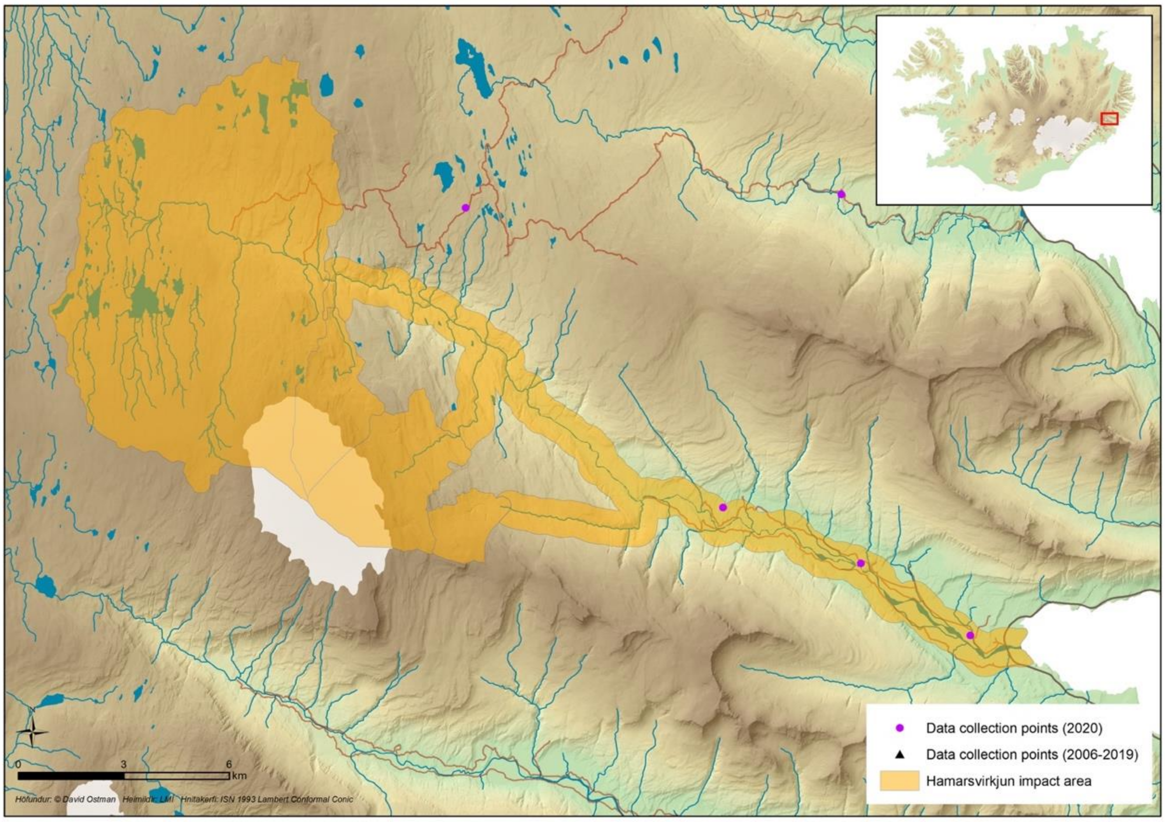


Fig. 3. Impact area and data points (2020 and older) for Hamarsvirkjun hydropower project

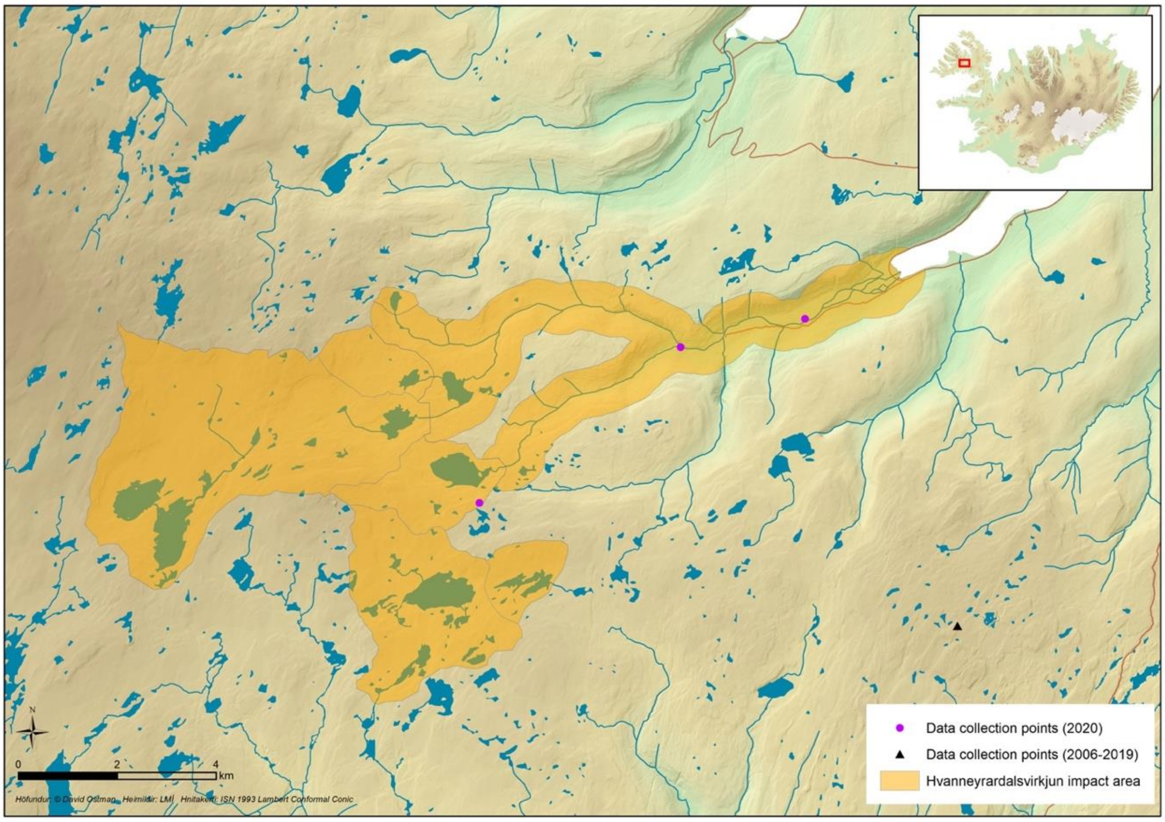


Fig. 4. Impact area and data points (2020 and older) for Hvanneyrardalsvirkjun hydropower project

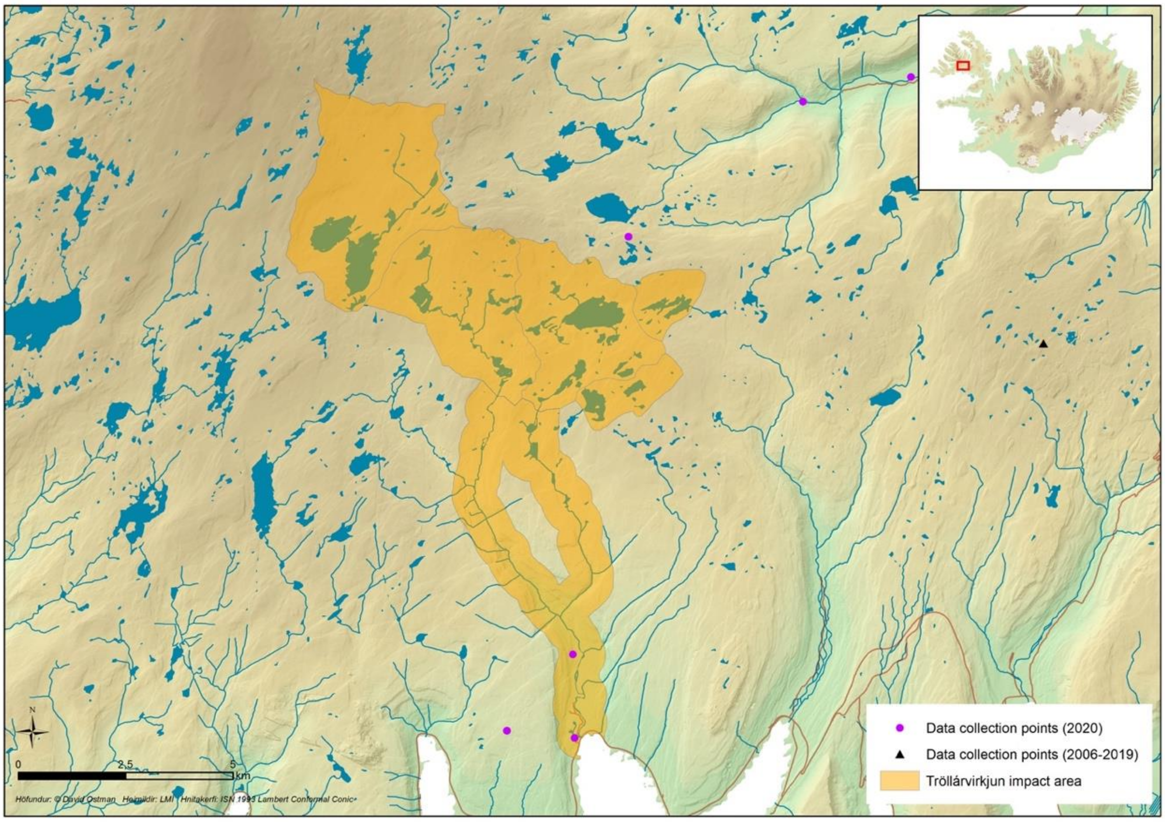


Fig. 5. Impact area and data points (2020 and older) for Tröllárvirkjun hydropower project

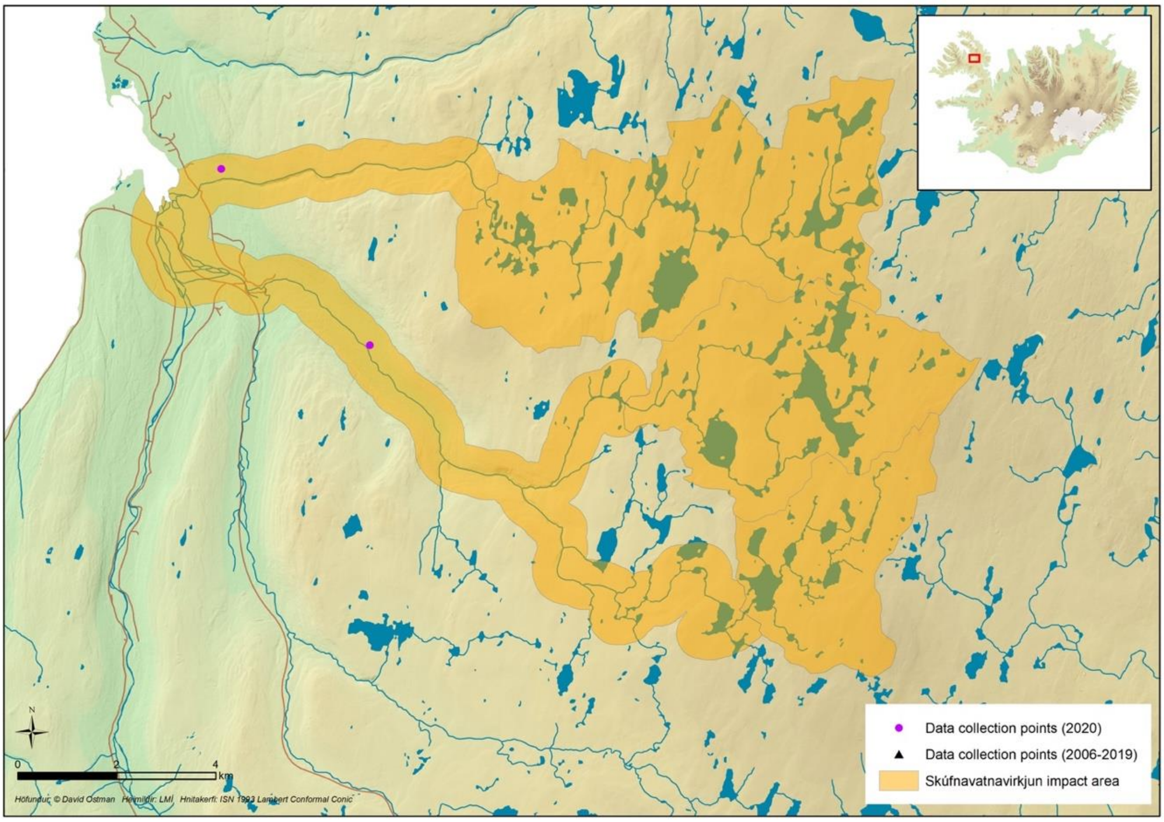


Fig. 6. Impact area and data points (2020 and older) for Skúfnavatnavirkjun hydropower project

2.2 Extensions to existing powerplants

Extensions to 3 existing hydropower projects are also being proposed as part of RÁ4: Vatnsfellsstöð, Sigöldustöð, and Hrauneyjafossstöð. Data points had already been collected as part of previous ILP fieldwork that fall within (and around) these extension areas (Figures 7 through 9), all of which were included in the most recent landscape classification analysis and other preparatory phase work. Therefore, priority for this summer's fieldwork was given to the newly-proposed project areas, specifically where previous fieldwork was sparse (or non-existent). Figure 10 shows an overview map of all 4 newly-proposed hydropower project impact areas and the 3 extension project locations.

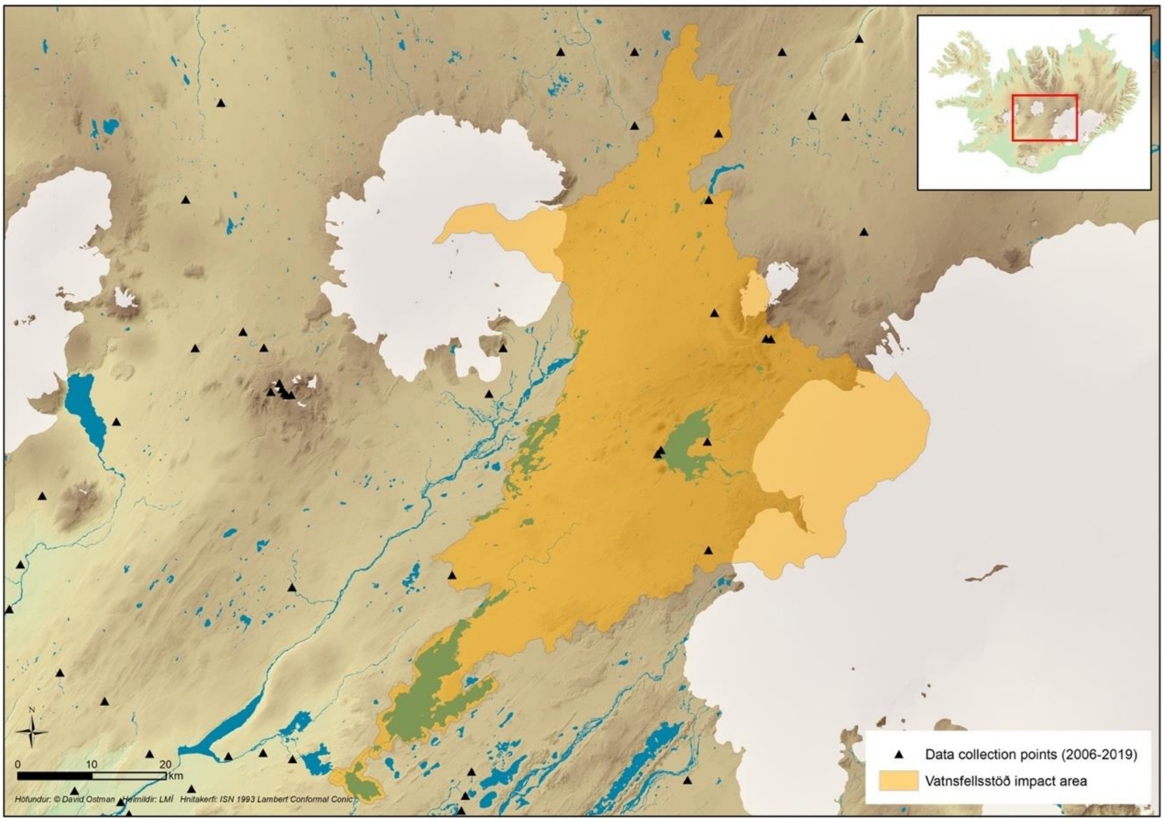


Fig. 7. Impact area and existing data points for Vatnsfellsstöð hydropower project

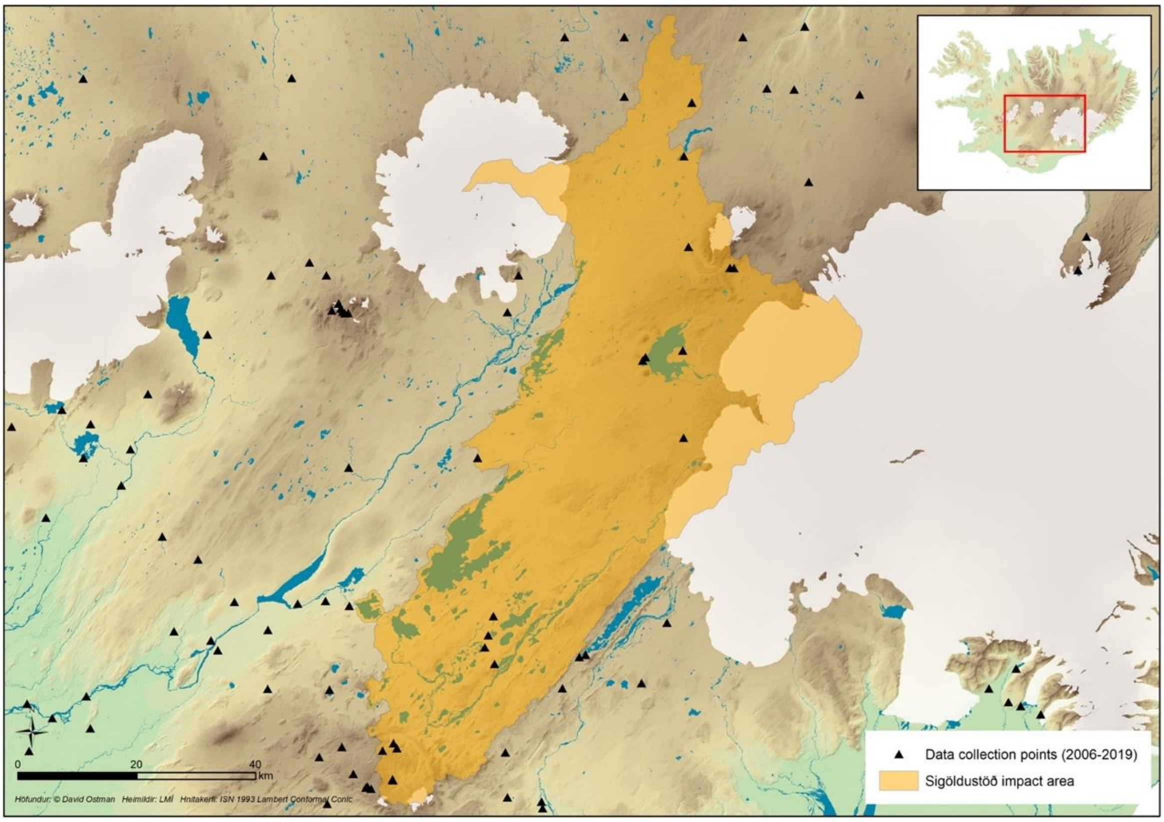


Fig. 8. Impact area and existing data points for Sigöldustöð hydropower project

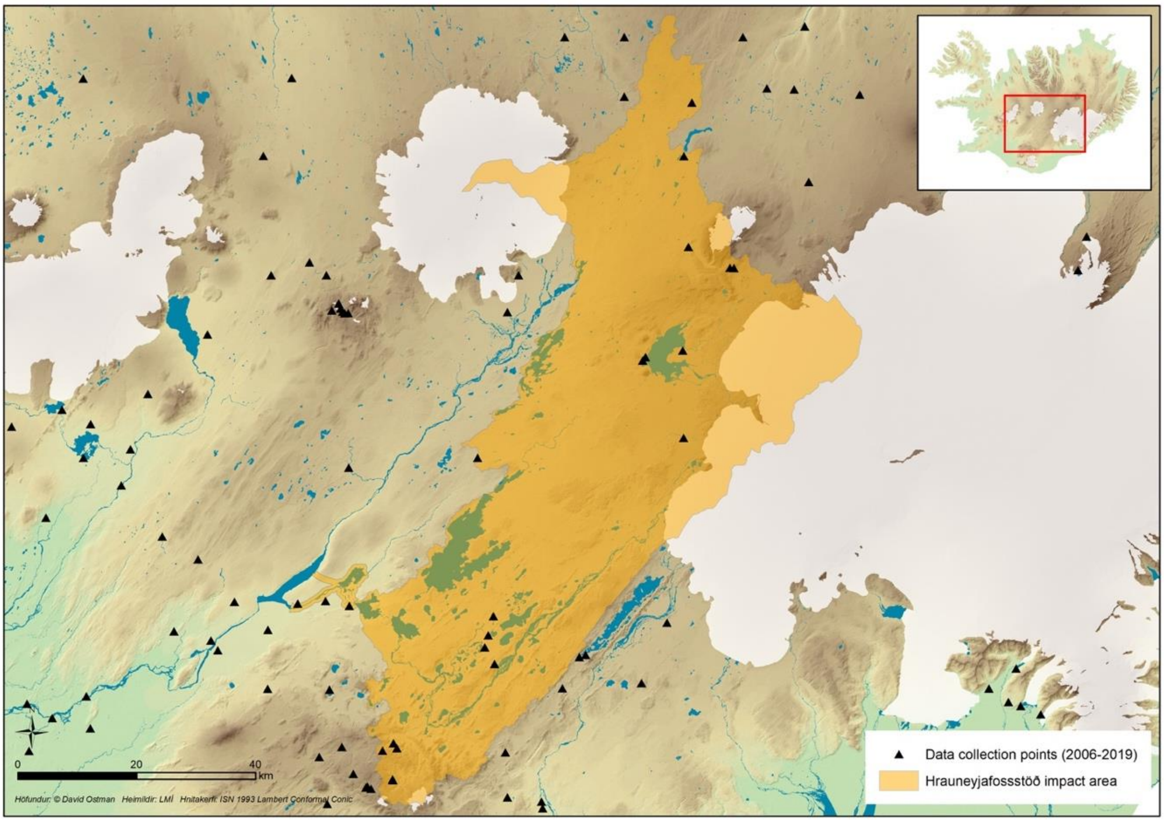


Fig. 9. Impact area and existing data points for Hrauneyjafossstöð hydropower project

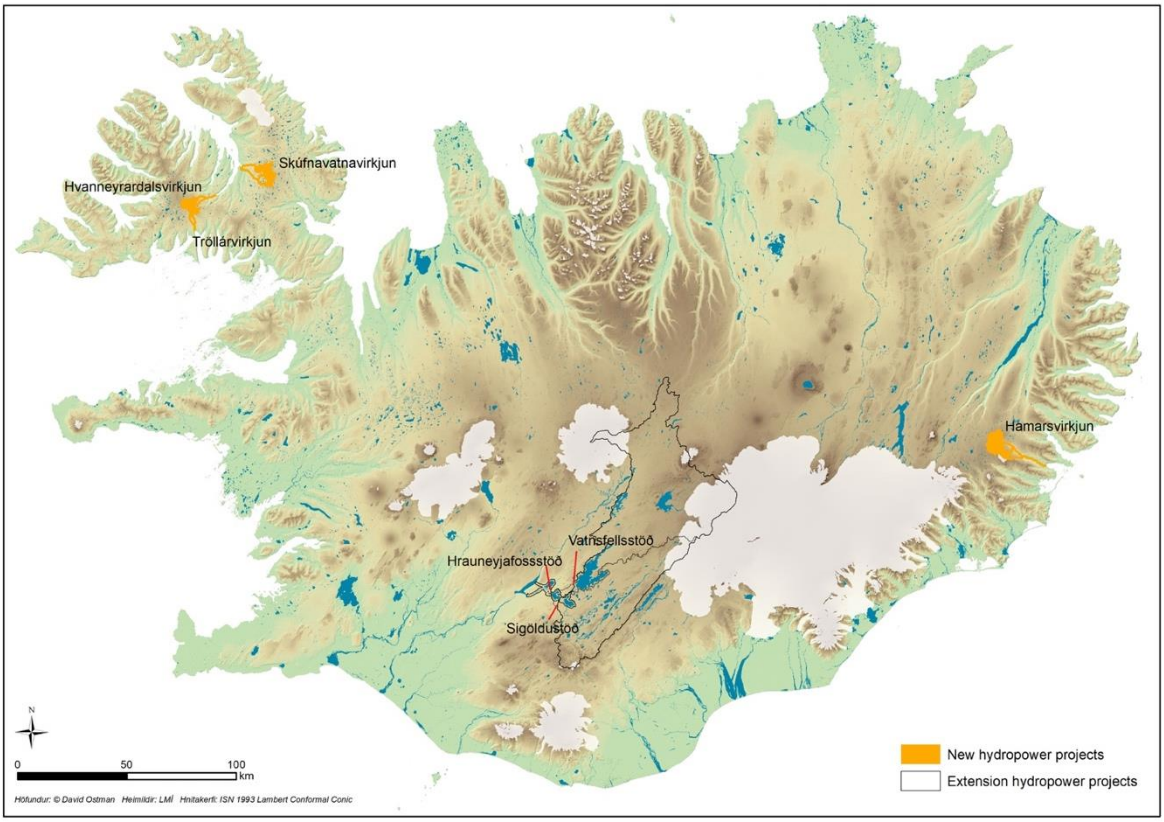


Fig. 10. Impact areas for all 4 new hydropower projects and 3 hydropower extensions projects

Also included as part of the assessment to determine the need for more data collection in and around the extension project areas was a preliminary visibility comparison of the project powerhouses *before* and *after* the theoretical construction of the extensions. Building dimensions of the existing powerhouses and the planned additions were obtained and verified from the submitted RÁ4 project proposal reports and through direct communication with Landsvirkjun, the power company proposing the extension (Albert Guðmundsson, email dated 21.09.2020).

The licensed visibility software*, Viewshed Explorer* (Carver, S. & Washtell, J., 2012), was used in this analysis, and a maximum distance radius of 5km was placed on the visibilities to focus on any substantial changes in the immediate vicinity. Figures 11 through 13 show the before and after visibility results for each of the 3 extension projects. 3D modeling was also conducted as a subcomponent of this analysis, using the new, high-resolution ÍslandsDEM (2 x 2m) to provide a more dynamic perspective of the existing powerhouse structures along with the visual impact overlays. Figure 14 provides a snapshot of this 3D modeling using the Vatnsfellsstöð powerhouse as an example. Based on this 2D and 3D analysis, it was apparent that the difference in additional coverage (i.e. increased visibility due to the powerhouse enlargements) and general landscape impacts for all 3 projects would be quite minor, and therefore, additional fieldwork in these areas was considered low priority.

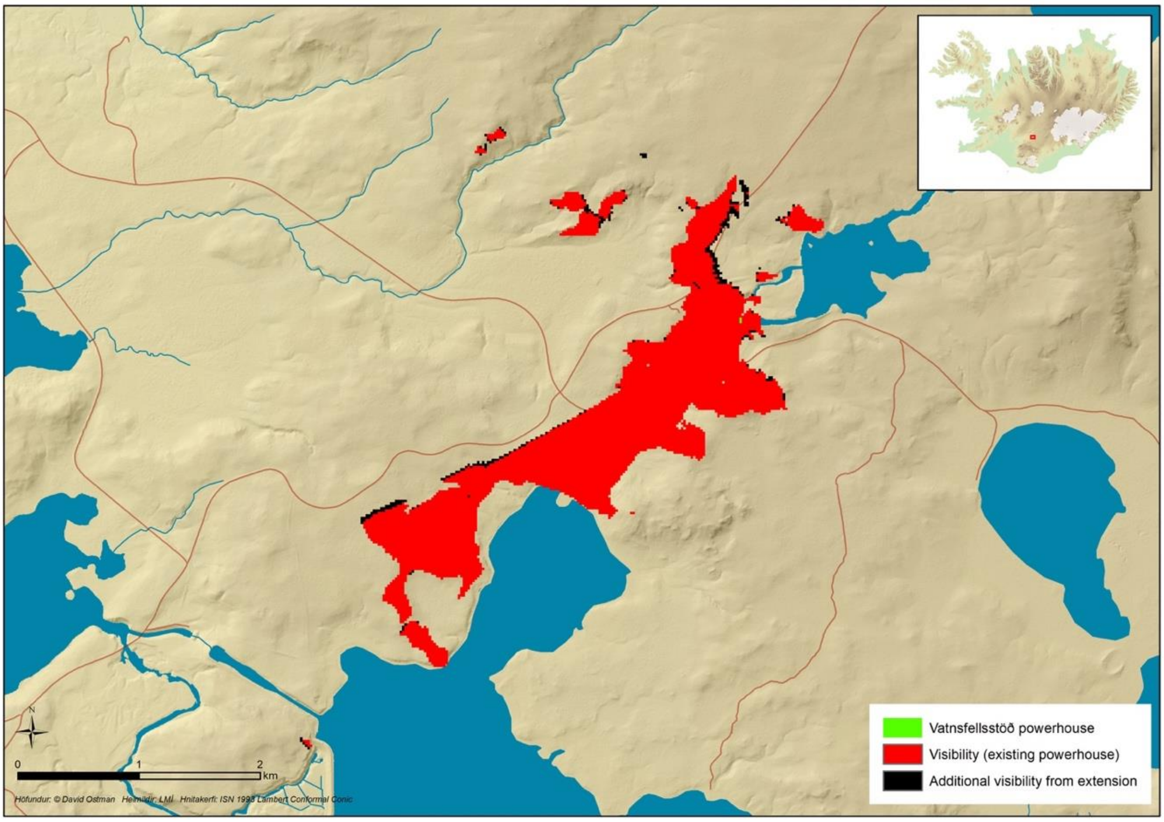


Fig. 11. Visibility results before (RED) and after (BLACK) the planned powerhouse extension for Vatnsfellsstöð

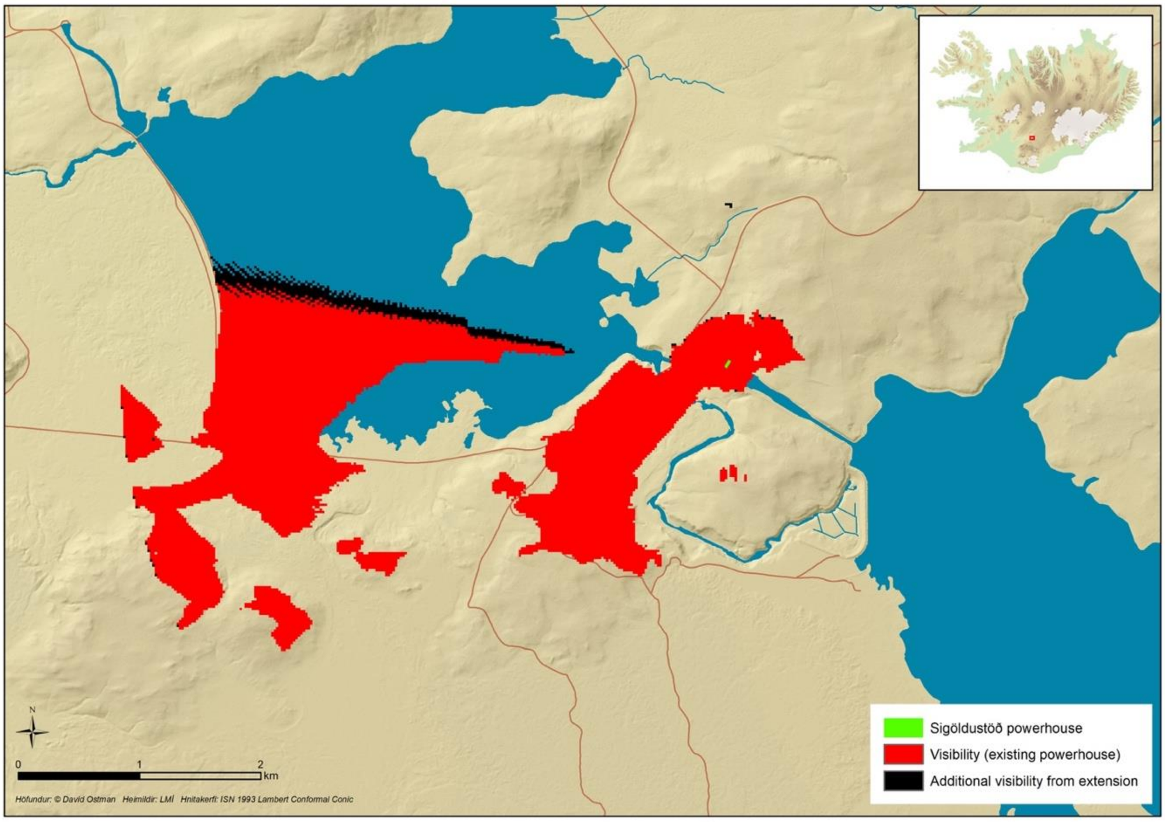


Fig. 12. Visibility results before (RED) and after (BLACK) the planned powerhouse extension for Sigöldustöð

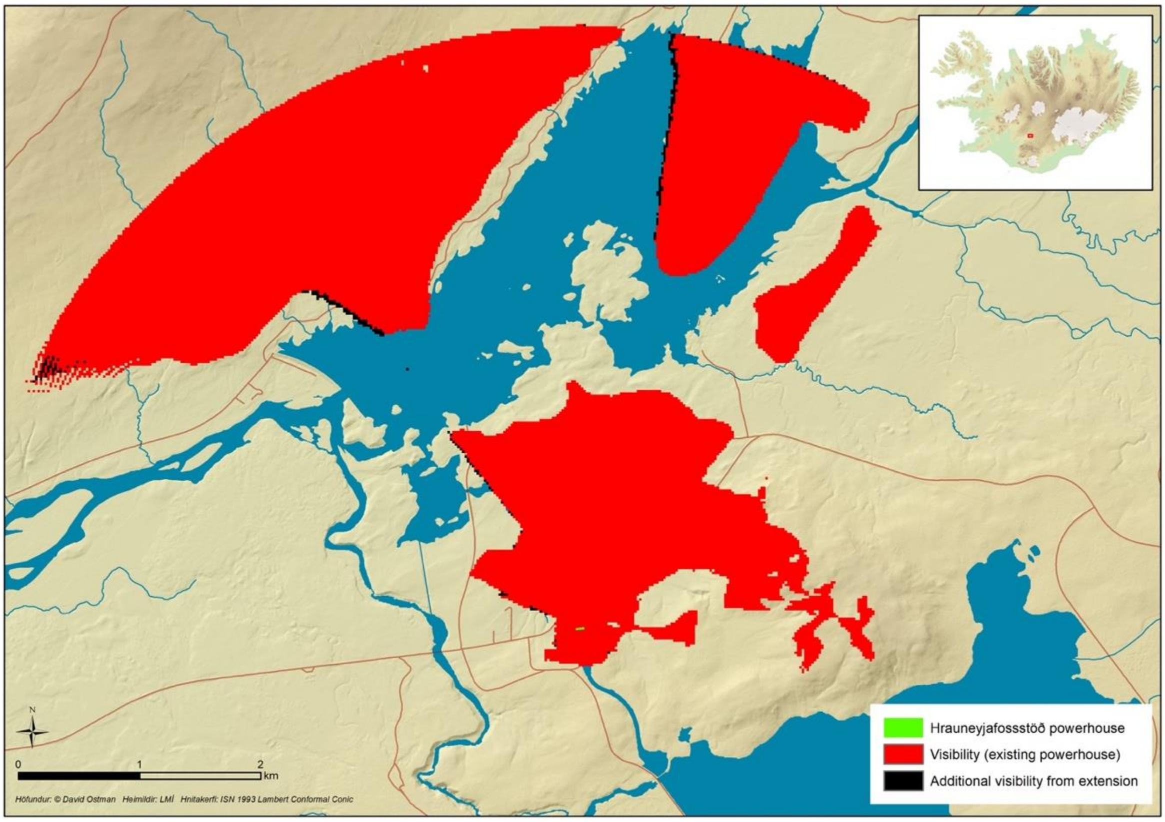


Fig. 13. Visibility results before (RED) and after (BLACK) the planned powerhouse extension for Hrauneyjafossstöð

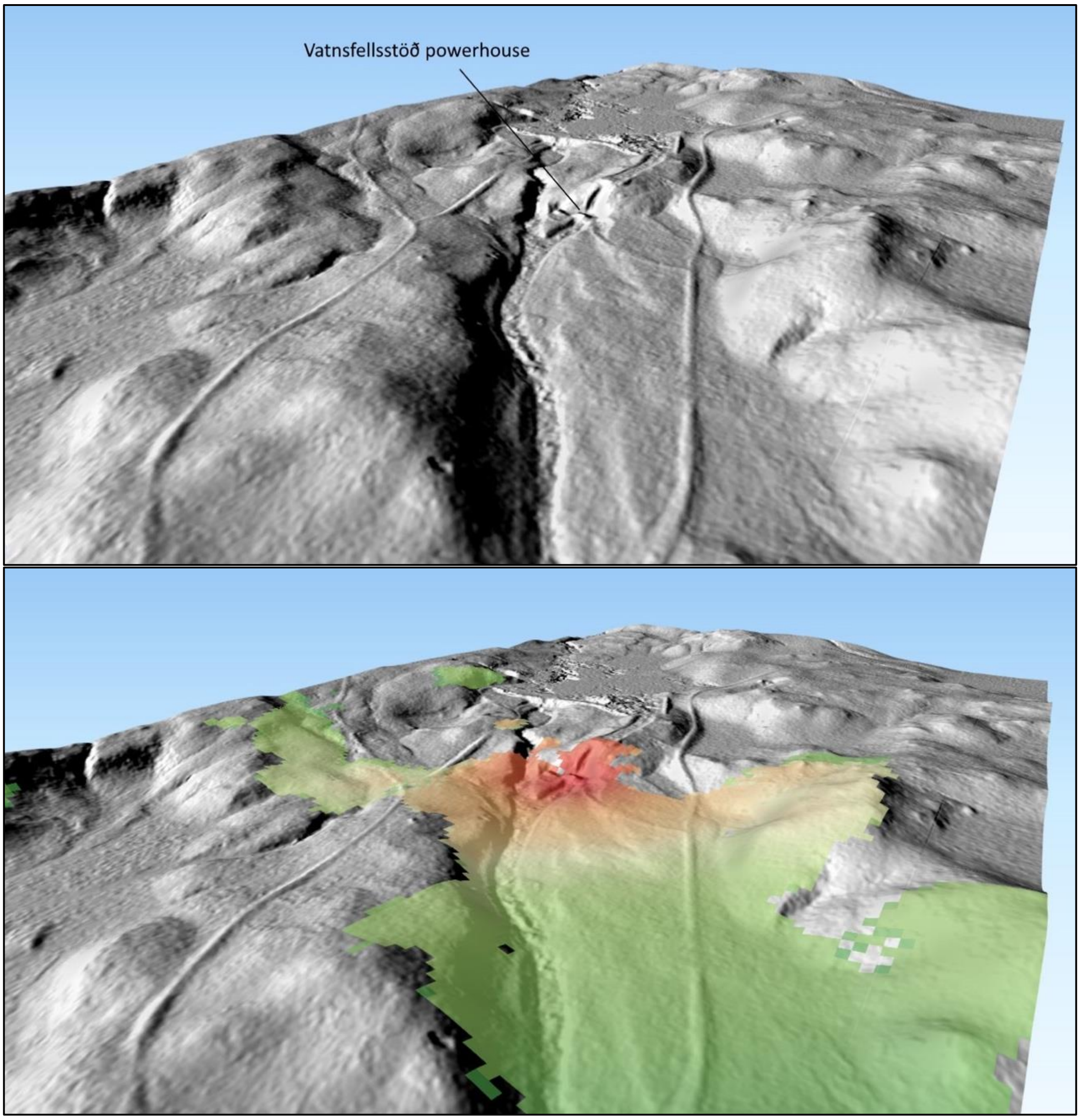


Fig. 14. 3D model snapshot of Vatnsfellsstöð powerhouse and surrounding area (top) with the added Viewshed Explorer visibility overlay (bottom)

3. Cluster analysis and updated landscape categories

3.1 Overview and past cluster analyses

In addition to their use for the assessment of the proposed projects in RÁ4, these newly-collected landscape data points contribute to a broader, ongoing research project of expanding the ILP classification system into a more robust landscape database and refined set of landscape categories. The classification of each data point into a particular landscape category is determined by how well they group together with other data points based on shared visual landscape features. These features include 22 visual characteristics of landscape (Table 1) that are assessed and recorded in the field using a checklist worksheet during the data collection process.

Table 1. Fieldwork checklist of landscape attributes used in cluster analysis

Landscape attributes	
Landscape contour	Diversity of patterns
Landscape depth	Texture (smooth, rough)
Elevation range	Texture diversity
Lines (straight, rounded, sharp, sinuous)	Water cover
Line diversity	Running water presence
Vegetation cover	Water diversity
Vegetation diversity	Sea presence
Color	Glacier & ice presence
Patch size of patterns	Overall diversity

A hierarchical cluster analysis was used to establish the landscape categories. The first round of analysis was conducted in 2010 in R, which resulted in 11 landscape categories based on 108 data points collected between 2006-2008. Figure 21 shows the final dendrogram groupings along with the corresponding landscape category descriptions. Further information on each category can be found on p. 87 in Þórhallsdóttir, Árnason, Bárðarson & Pálsdóttir (2010).

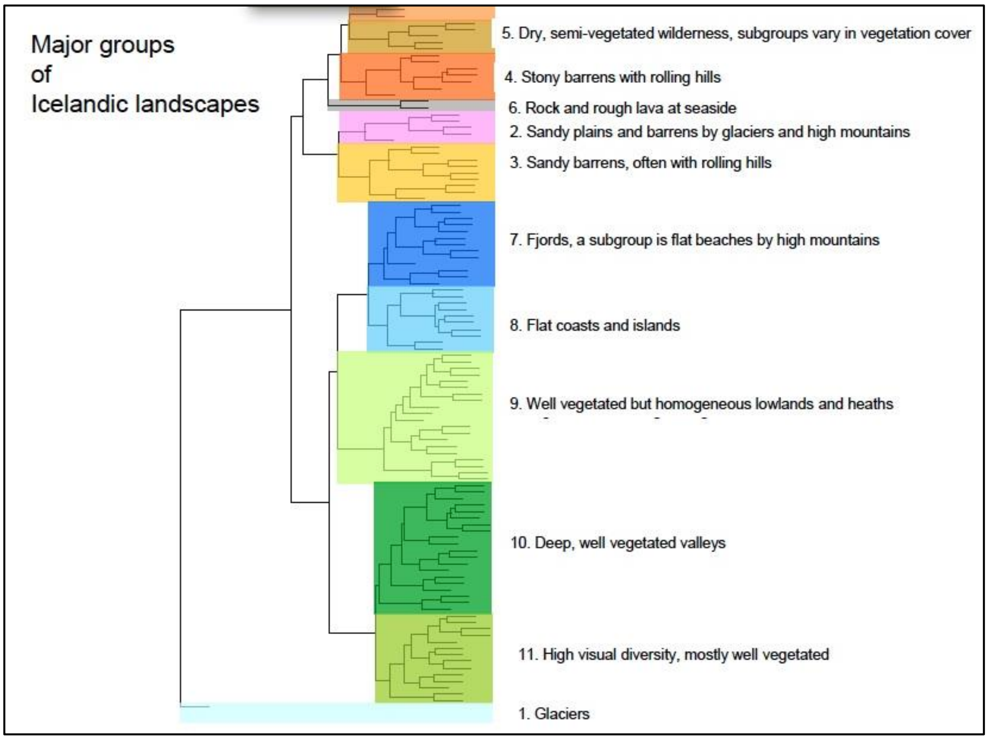


Fig. 21. Original 2010 dendrogram results and 11 landscape categories based on the initial 108 data points collected between 2006-2008 (Þórhallsdóttir et al., 2010)

The second round of analysis in 2016 also used R for the point clustering and incorporated the additional 67 new data points that had been collected in the summer of 2015. The main difference in this second round of analysis was that 4 of the 22 landscape variables - basic shape (*grunnlögun*), vegetation cover (*gróðurþekja*), sea presence (*sjór*), and glacier presence (*jökull*) - were determined to be more defining and dominant visual characteristics of the landscape and were therefore given a corresponding weight (0.5) in the dataset.

The resulting dendrogram showed the grouping of these 175 points based on their shared landscape features, and 11 new landscape categories were established (Fig. 22), most of which were very similar to the original 11 categories formulated in 2010.

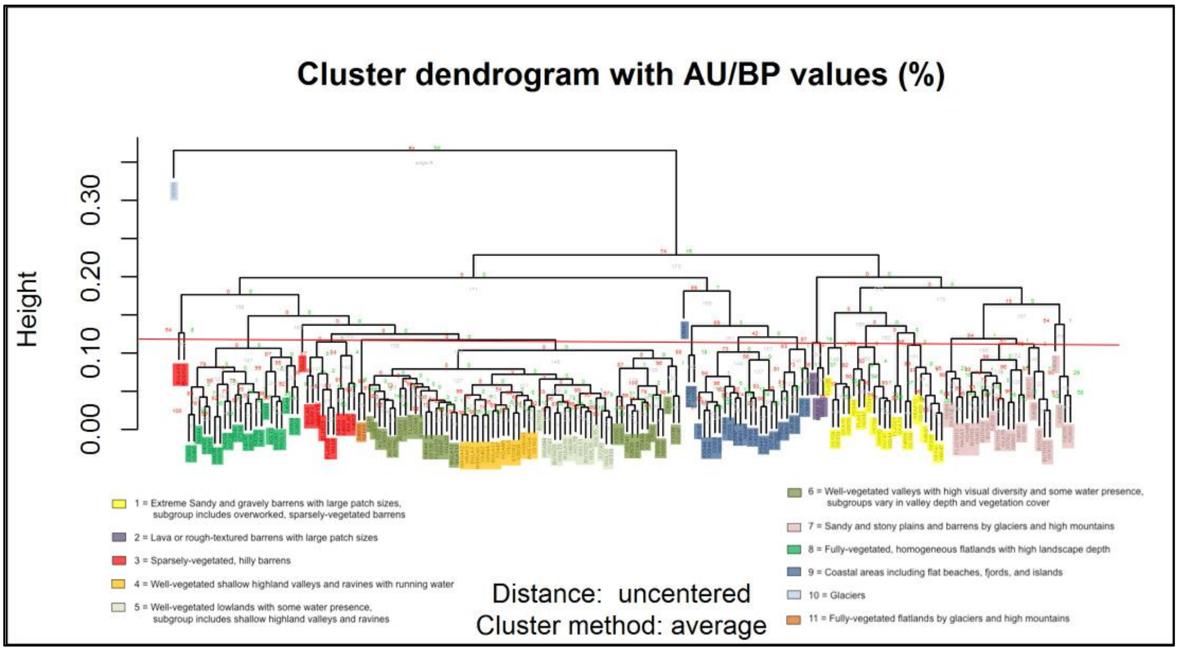


Fig. 22. Dendrogram results from R cluster analysis in 2016, incorporating an additional 67 points for a total of 175 points, also showing the color-coded 11 latest landscape categories. The RED line indicates the general cut-off height (0.123) used to help determine general group divisions

This second round of analysis showed that a few of the original landscape categories based on the 2010 dendrogram were 'broken apart'. One of the reasons to explain this grouping alteration may be the inherent nature of how the cluster analysis deals with new data. That is, when adding in the newer points that contain potentially new variations of landscape feature information, which may not have existed in the original data set, the original dendrogram groupings may expand or contract with some points getting 'pushed out' into other groupings that share a more similar data set. What may have been considered 'similar' in a smaller data set may not be so 'similar' in a larger one. New data may result in nuanced versions of existing landscape categories and even the potential of new categories.

The third round of cluster analysis was conducted in early 2020 based on the addition of 45 new data points collected in the summer of 2019, as well as six points collected in the summer of 2016, and a series of older, targeted points based on their status as a 'geothermal' or 'nature pearl' site (39 and 45 points, respectively). Altogether, 310 points were processed. SPSS was used in this round of clustering instead of R, as SPSS was able to produce similar results as R but with more ease and efficiency. After finding some logical divisions in the resulting dendrogram branches, and using a general 'cut-off' height of about '10', 12 landscape categories were demarcated. The resulting dendrogram and distinguished landscape groups are shown in Figure 23.

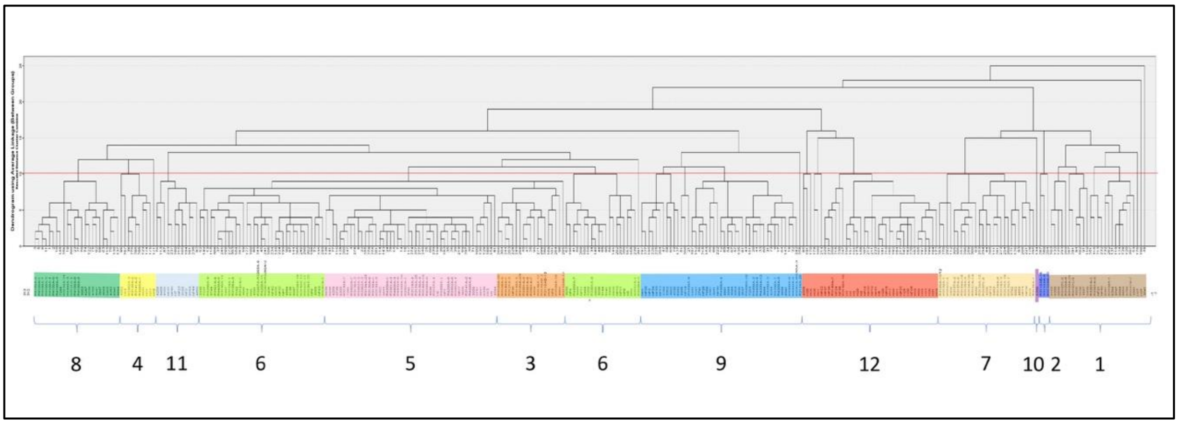


Fig. 23. Dendrogram and new landscape category grouping results from SPSS cluster analysis in early 2020, based on all data collection points to-date (310 points total). A general 'cut-off' height of about '10' (indicated by the RED line) was used to help determine logical divisions in the groupings

3.2 Latest cluster analysis and final landscape categories

The fourth, and most recent, round of cluster analysis (SPSS) took place in September 2020, based on the addition of 33 new data points collected in the summer of 2020 to the existing data set. Similar to the two previous rounds of analysis, 4 of the 22 landscape variables - basic shape (*grunnlögun*), vegetation cover (*gróðurþekja*), sea presence (*sjór*), and glacier presence (*jökull*) - were given a weight (0.5) in the dataset in order to highlight the more defining and dominant visual characteristics of the landscape. In SPSS, the 'between-groups linkage' cluster method using the 'cosine' interval were applied as this combination had best recreated the original 2010 dendrogram results that were initially run in R.

Altogether, 343 points were processed in this latest analysis. The resulting dendrogram was then color-coded based on the most recent ILP classification categories to see how well the groupings stayed together. The newest 33 points added in this analysis would, of course, not yet have a category assigned to them, but once all other points were color-coded, then it was possible to see if these remaining, newest points 'fit in' amongst the older points. If the old and new points grouped together well in the dendrogram based on the existing, color-coded categories (e.g. there were not too many outliers, and the color-coded categories grouped together well), then the new points could be tentatively assigned their appropriate landscape category. The appropriateness of the landscape category for each new point could be verified by checking if the fieldwork photos and video of those points align with the visual characteristics of their newly-assigned category description. They could also be compared to the photos and video of older points from the same category.

Once these preliminary categories (old and new points) in the dendrogram were distinguished, the data from all 343 points were then put into an excel spreadsheet and grouped based on these preliminary categories. The averages of all 22 landscape variable ratings for each grouping were calculated. The rating scale for each variable was 0-5 (0 = lowest, 5 = highest). A heat map was then created (Table 2) for these averages to help highlight extreme high and low variable ratings and ultimately help reveal distinct landscape features within a particular category.

The heat map results, along with any necessary visual references to the photos and videos for the data points, also determined distinguishing features and justification for the latest categories and their respective written descriptions.

Table 2. Heat map of the 22 landscape variable rating averages (scale 0-5) for each of the 12 landscape categories. Dark RED indicates a lower rating, and dark GREEN indicates a higher rating

Fall 2020 Cat	Grunnlogun	vidsyni	breytileiki I head	beinar	avalar	hvassar	svigthur	fjolform	grodurthekja	grodurfjol	litbrigthi	blettastærd	mynstfjol	aferdfjol	aferdhrjuf	aferdslett	vatnthekja	straumur	Vatnfjol	Sjor	Jokull is	Fjolbreytni
6	1.4	1.7	3.8	2.7	2.7	1.7	3.0	3.0	4.3	2.8	2.8	3.0	2.9	3.2	2.9	3.4	1.9	2.6	1.6	0.3	0.1	2.8
5	3.1	2.5	3.1	1.9	3.0	0.8	2.4	2.4	4.5	3.1	2.6	3.4	2.6	2.5	2.1	3.8	1.9	1.6	1.4	0.1	0.0	2.5
4	2.9	2.1	3.0	1.1	3.0	1.3	1.3	2.3	4.1	2.6	2.8	2.7	2.9	3.1	3.1	3.2	0.0	0.0	0.2	0.2	0.1	2.5
3	3.1	2.1	3.5	1.4	3.1	1.6	2.9	2.9	2.5	2.0	2.5	2.9	2.7	3.0	3.3	3.0	1.8	2.4	1.5	0.1	0.0	2.6
8	2.9	3.7	2.3	1.6	1.8	0.2	0.6	1.3	4.8	2.6	2.2	3.6	1.9	2.0	1.5	4.2	1.0	0.9	0.8	0.2	0.0	1.8
9	2.5	2.9	3.6	2.2	2.1	1.5	2.0	2.6	3.7	2.3	2.8	3.3	2.7	3.0	2.5	3.7	0.9	1.0	0.8	3.6	0.3	2.5
12	1.9	1.7	2.5	1.0	3.1	1.9	2.8	3.4	2.0	1.4	3.8	2.5	3.8	3.7	2.5	3.3	2.4	1.9	2.1	0.0	0.1	2.9
2	2.8	2.5	3.5	3.0	2.5	2.0	1.3	2.3	0.3	0.3	1.5	4.3	1.5	1.3	4.8	2.8	0.3	0.5	0.3	0.5	0.5	1.5
1	3.2	3.1	2.7	0.8	3.4	0.5	1.7	1.8	0.5	0.6	1.7	4.3	1.5	1.8	2.4	3.5	1.3	1.3	0.9	0.0	0.2	1.5
7	2.9	2.6	3.9	1.4	3.3	1.5	2.5	2.9	0.9	0.9	2.6	3.8	2.8	2.7	2.5	3.6	2.0	1.9	1.7	0.1	3.3	2.5
11	3.0	2.8	3.5	0.8	3.4	1.7	2.5	3.0	3.5	2.0	2.7	3.1	3.3	3.2	2.5	3.3	1.8	1.2	1.2	0.1	2.8	2.7
10	3.0	5.0	2.0	0.0	4.0	3.0	0.0	2.0	0.0	0.0	1.0	5.0	2.0	1.0	2.0	4.0	0.0	0.0	0.0	0.0	5.0	1.0

Logical divisions were also found in the resulting dendrogram branches, and a general 'cut-off' height of about '9' was used. Based on these above mentioned assessments (i.e. color-coding of the existing landscape category groupings, reference to certain point photos and video, heat map results, and logical branch divisions), 12 categories were demarcated. The final dendrogram and distinguished landscape groups are shown in Figure 24.

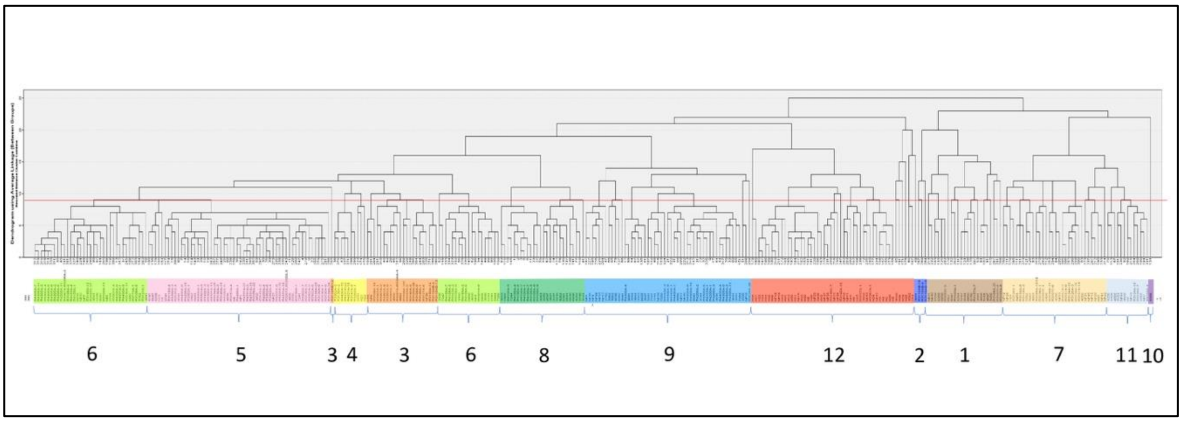


Fig. 24. Dendrogram and new landscape category grouping results from the most recent cluster analysis (SPSS) in September 2020, based on all data collection points to-date (343 points total). A general 'cut-off' height of about '9' (indicated by the RED line) was used to help determine logical divisions in the groupings

The 12 category groupings from the previous analysis (early 2020) remained intact, with a handful of points being 'bumped' out of one category and into another, most likely due to the enhanced and more nuanced data set with the additional 33 new points. The number and type of categories also remained the same, besides a couple of small wording tweaks made to the category descriptions to provide a more accurate representation of each group. The written descriptions of each landscape category are shown in Table 3.

Table 3. Descriptions of 12 landscape categories based on the latest round of cluster analysis in September 2020

Category Number	Category Description
1	Sandy and stony barrens with large patch sizes
2	Lava or rough-textured barrens with large patch sizes
3	Sparsely to semi-vegetated hilly barrens with some rough texture, water and stream presence
4	Semi to well-vegetated, dry, shallow valleys and barrens with some rough texture
5	Well-vegetated, shallow valleys and flatlands with some water presence
6	Well-vegetated, deep valleys, intermixed smooth and rough texture, with some water and stream presence
7	Sandy and stony plains and barrens by glaciers and high mountains
8	Fully-vegetated, homogeneous flatlands with high landscape depth
9	Coastal areas including flat beaches, fjords, and islands
10	Glaciers
11	Semi to well-vegetated areas by glaciers and high mountains
12	Valleys of high visual diversity. Subgroup includes geothermal areas with little to no vegetation.

Figure 25 provides a spatial distribution of all 343 data point locations, color-coded by the latest landscape categories. This visual display not only exhibits a good overview of where the varying landscape types fall geographically in relation to each other, but it can be a useful tool to help identify potential outliers, establish the emergence of patterns, and verify that the assigned category in a particular location seems logical. For instance, the majority of category 8 points (*fully-vegetated, homogeneous flatlands*) are clustered together in the southwest lowland plains of the country, which one would expect. Also, the majority of points in categories 1 (*sandy and stony barrens with large patch sizes*) and 7 (*sandy and stony plains and barrens by glaciers and high mountains*) are largely found within the high plateau 'barrens' of the Central Highland.

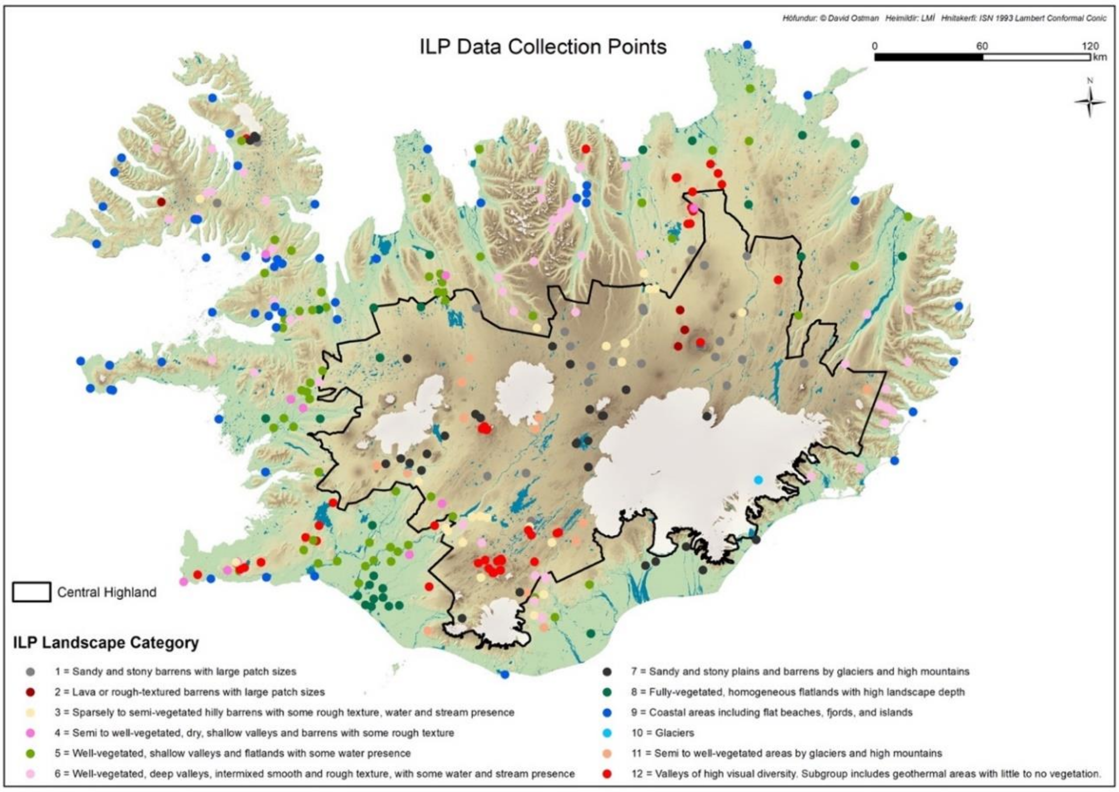


Fig. 25. Map showing all 343 data collection point locations color-coded by the 12 latest landscape categories

To test the resiliency of how well these categories remain grouped together, the newly-collected 33 points were processed in a cluster analysis on their own and then color-coded based on the 12 categories to see if they would group together similarly (Fig. 26). A similar experiment was conducted with just the original 108 points (Fig. 27). With a few outliers to be expected in both cases, it is visually clear that the groupings remain relatively intact.

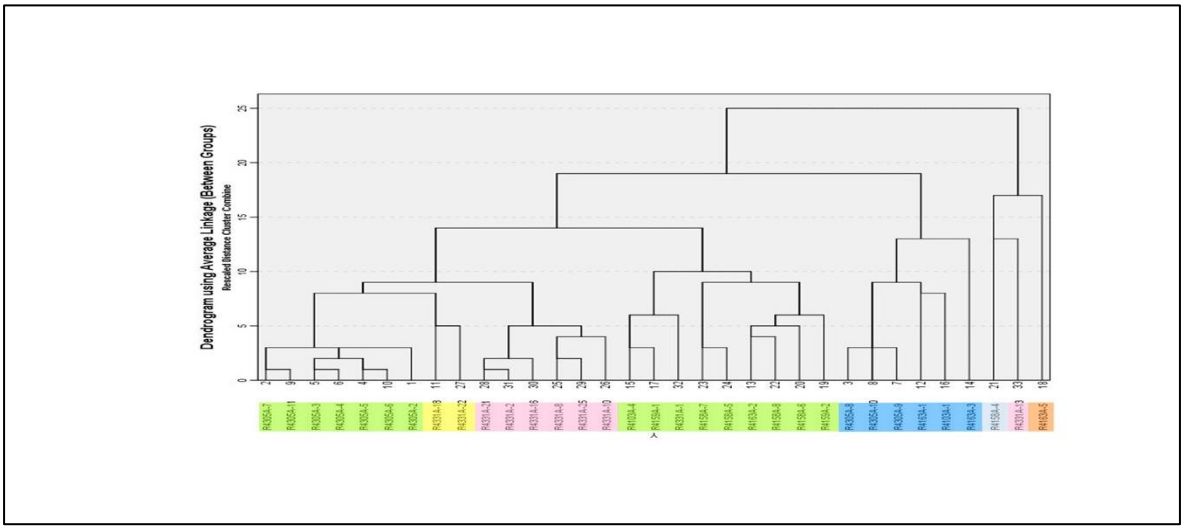


Fig. 26. Dendrogram results of the 33 data points collected in the summer of 2020, color-coded by the 12 latest landscape categories

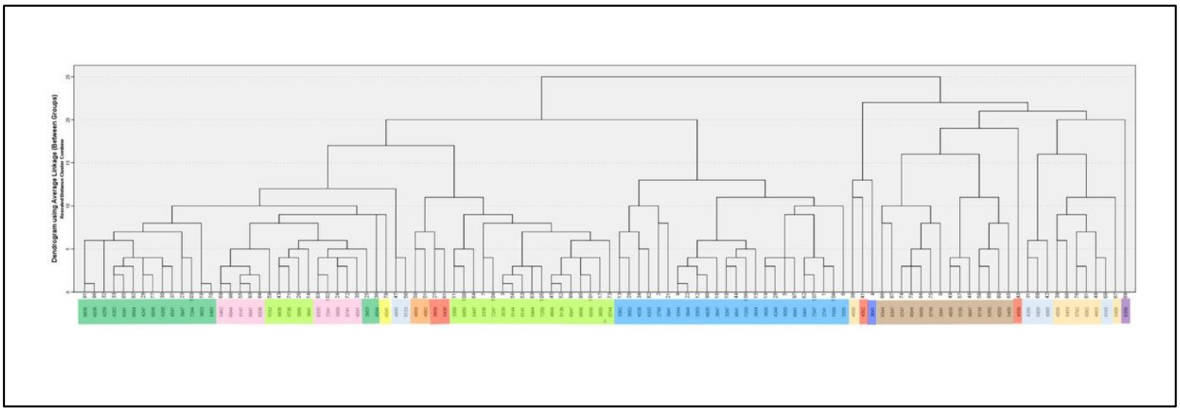
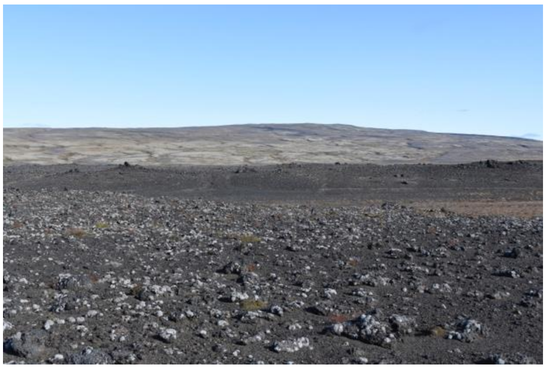


Fig. 27. Dendrogram results of the original 108 data points collected between 2006-2008, color-coded by the 12 latest landscape categories

Amongst the 2019 and 2020 data points targeted and collected for RÁ4, 7 of the 12 possible landscape categories are represented. Those 7 category descriptions and a sample photo for each category are presented below.

***Category 3**:* Sparsely to semi-vegetated hilly barrens with some rough texture, water and stream presence



Category 4: Semi to well-vegetated, dry, shallow valleys and barrens with some rough texture

Category 5: Well-vegetated, shallow valleys and flatlands with some water presence

Category 6: Well-vegetated, deep valleys, intermixed smooth and rough texture, with some water and stream presence

Category 8: Fully-vegetated, homogeneous flatlands with high landscape depth

Category 9: Coastal areas including flat beaches, fjords, and islands

Category 11: Semi to well-vegetated areas by glaciers and high mountains

Due to the exploratory nature of how cluster analysis is used in this context of constantly changing data sets (i.e. always adding in new rounds of collected data points), it is important to keep in mind that this process is partially a manual one. For instance, decisions may need to be made on the potential creation of new categories, the dissolving of existing categories into others, or adjusting category descriptions based on their most dominating and representative characteristics. There will, of course, be outliers and some points that may be appropriate in more than one category.

This raises the question of re-evaluating the overall divisional structure of the category groupings and the potential of including sub-categories. One may e.g. use a higher 'cut-off' height in the dendrogram, which would yield a smaller number of less descriptive categories that would be applicable to a larger number of points (e.g. *fully-vegetated valleys* instead of *semi to well-vegetated deep valleys with water and stream presence*). The concept of using sub-categories might be useful here, for example, if there are point groupings within this more general category that share similar features. It is possible that under this *fully-vegetated valleys* category, there are a cluster of points with and without water presence, or the valley deepness varies considerably, so grouping these points into sub-categories based on further distinguishing features should be considered.

Conversely, one may use a lower 'cut-off' height resulting in a larger number of more descriptive categories, each containing a smaller number of points. In this case, sub-categories would be obsolete. These questions acknowledge the partially-subjective nature of this process, and ultimately, the actual use of these categories (for local vs. nationwide land use planning, etc…) should dictate their resolution and scope.

This method of point-based landscape classification in Iceland is still in its developing stages. Also, a good deal of ground remains to be covered in terms of data collection points around the country, which means that as more data points are collected and added to the ILP classification database, new variations of landscape types are likely to be revealed, and this may yield a growing number of more refined landscape categories and sub-categories. This may result in some data points switching amongst categories and changing their dendrogram position in order to align more accurately with new data. So the potential of adding new classifications or making fine-tunings to older categories speaks less about the robustness of the ILP methodology and the resulting dendrogram and more about having to adapt to additional, more nuanced data.

4. Wilderness characteristics

An integral component of the data collection process - alongside evaluating the visual traits of the landscape - is documenting wilderness characteristics. Defining that which is considered to be 'wild' can be conceptually delicate and requires continued deliberation (Árnason, Þ., 2020). However, generally speaking, it is widely accepted that wilderness can exist on a spectrum (Nash, 1993) and is a composite of both physical and perceptual qualities (Vucetich, J. A. & Nelson, M. P., 2008). The wilderness checklist, created in 2015 (Hoffritz, A, Ostman, D. & Árnason, Þ., 2016) and used in all subsequent fieldwork, acknowledges these notions and consists of rating a series of anthropogenic and non-anthropogenic (perceptual) attributes on a scale from 0 (non-existent) to 5 (highly-present). The specific checklist attributes are shown in Table 4.

Table 4. Fieldwork checklist of wilderness attributes, each rated on a scale of 0-5

Wilderness attributes checklist	
Anthropogenic features	**Non-anthropogenic features**
Buildings (few-many, small-large)	Untrammeled
Proximity to facilities	Primeval
Roads (few-many, difficult-easy)	Unconfined
Traffic (light-heavy)	Ruggedness
Traffic type (foot, vehicle, air)	Solitude
Traffic noise	Surprise
Power lines	Well-being
Fences	Peacefulness
Other infrastructure	Wonder / awe
Animals / livestock	Humbleness

The attribute ratings are inputted into a spreadsheet, and a simple wilderness score for each data point is derived by taking the sum of the non-anthropogenic ratings minus the sum of the anthropogenic ratings. This provides an easy, numerical method of comparing an overall level of wilderness quality amongst locations, which can then be visualized spatially on a map.

Figure 28 shows all of the locations where wilderness checklist data has been collected, with each point color-coded based on its respective wilderness score. The spatial distribution proves to be logical, with the higher wilderness scores (GREEN) found generally in more remote, less-inhabited areas (e.g. the West Fjord mountain ranges and within the Central Highland) and the lower scores (RED) found closer to more populated or built-up areas. One special case worth noting is that of the region just northeast of Búrfell í Þjórsárdal, which shows noticeably lower wilderness scores than any other part of the Central Highland. This is due to a series of built-up roads, a hotel, and a cluster of power plant infrastructure (two research wind turbines; powerlines; and a series of hydropower dams, canals, and reservoirs). The region would otherwise resemble the more natural qualities of the rest of the Central Highland - widely cherished for its ability to exude feelings of 'wildness'.

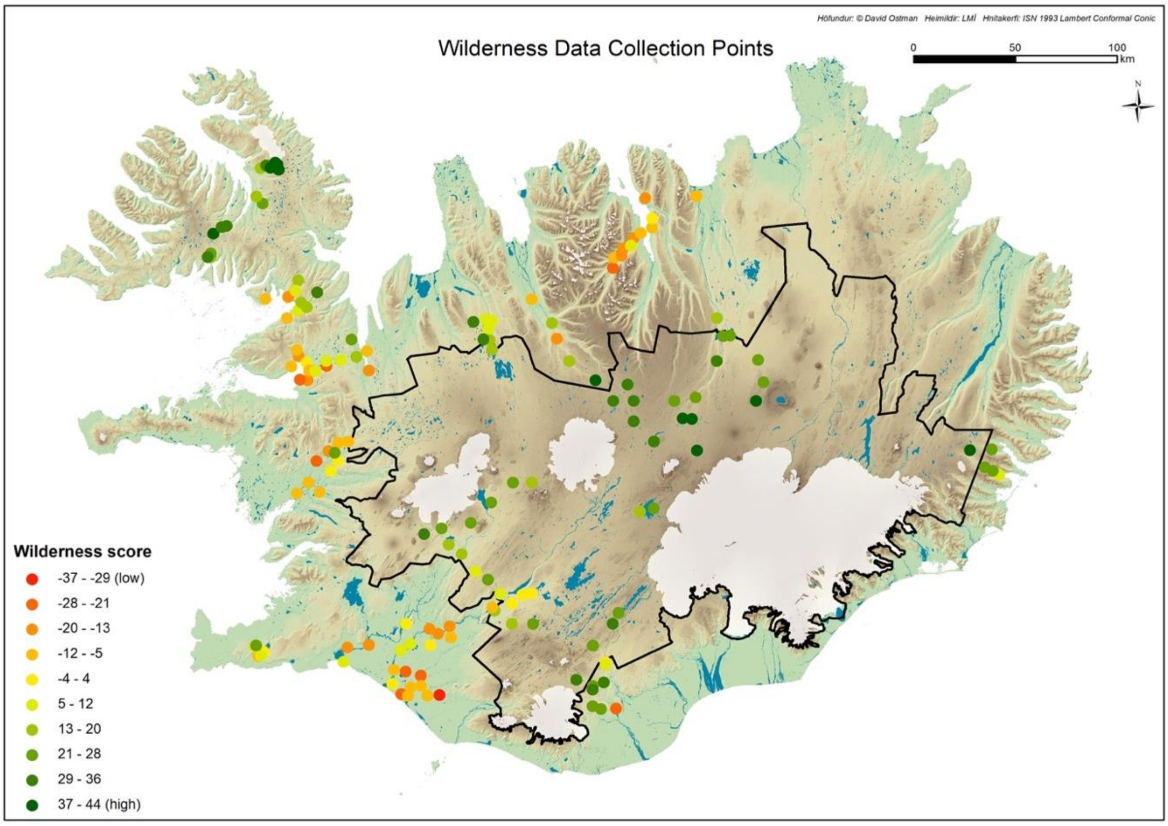


Fig. 28. Data point locations where wilderness checklist data has been collected. Color-coded by the wilderness scores (GREEN = high, RED = low).

5. Conclusion

This report provides an overview of the most recent round of landscape and wilderness data collection, conducted in the summer of 2020. It also discusses the methodology of the ILP landscape classification system (hierarchical cluster analysis approach), both in previous analyses and in its most recent application with the incorporation of new data collected this summer. The resulting 12 landscape categories are presented, followed by a brief discussion on the wilderness checklist and attributes. The data collection locations were primarily targeted based on the proposal of new energy projects submitted for RÁ4 in order to ensure sufficient data in those areas so that the value of landscape and wilderness - and any potential impacts due to the proposals - can be properly evaluated. The post-fieldwork analysis and project evaluations are currently underway, with the visibility and landscape impacts of wind farms having a particular focus (Ostman, D. & Árnason, Þ., forthcoming).

Beyond its use in RÁ4, this data collection also serves a larger, more general research purpose by contributing to the growing corpus of knowledge regarding landscape and wilderness characteristics in Iceland. More visited sites and a larger database (photo and video documentation, checklist assessments) provide a more nuanced understanding of the country’s diverse nature and assist in ground-truthing current and future desktop-based mapping and classification methods.

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Addendum I: Geothermal projects (Svartsengi extension)

An extension to an existing geothermal project, Svartsengi, was proposed as part of RÁ4. Previous ILP fieldwork had already been conducted in the vicinity of this extension area, so priority for field work was given to the newly-proposed project areas, specifically where previous fieldwork was sparse (or non-existent). When data collection was finished for the new projects, two additional data points were collected for Svartsengi late in the 2020 season, which occurred after the initial drafting of this report. Figure 29 shows an overview map of the Svartsengi project impact area and the proposed drilling sites. It also shows the newly-collected (and older) data points used in the assessment.

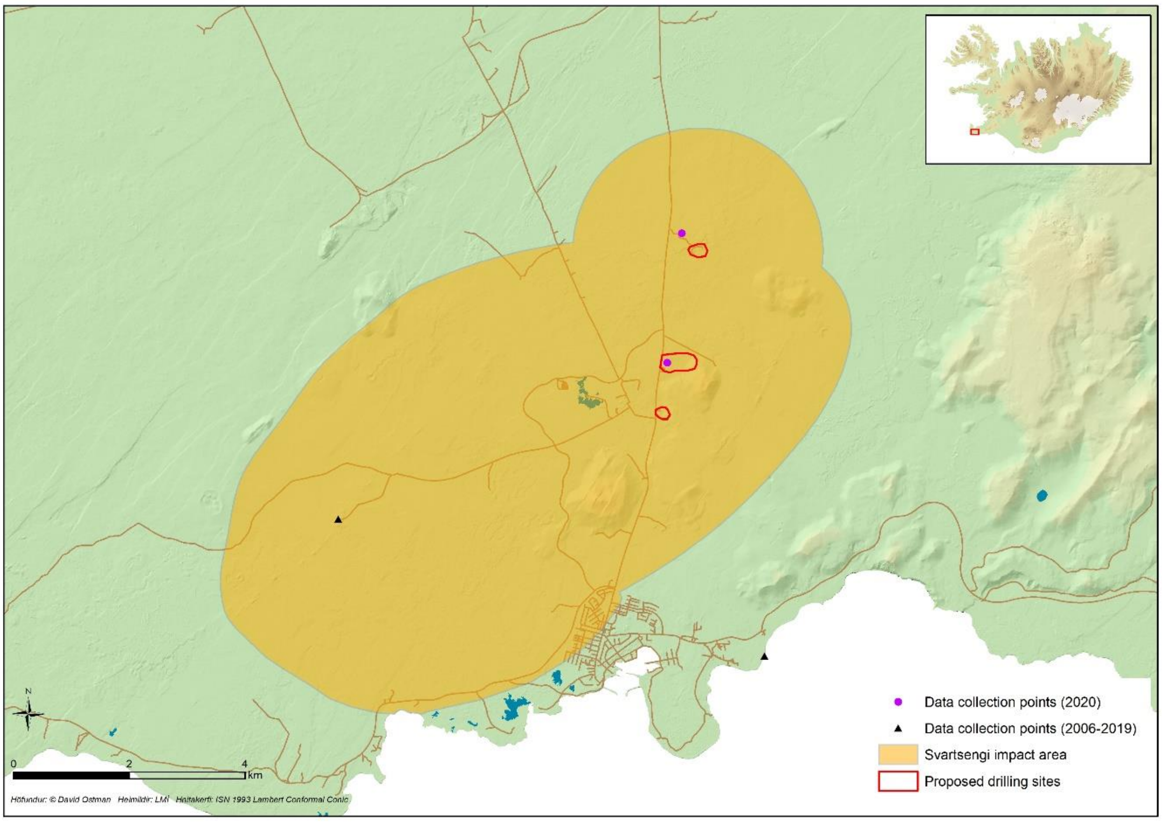

Fig. 29. Impact area, proposed drilling sites, and data points (2020 and older) for Svartsengi geothermal project

Addendum II: Updated ILP cluster analysis, including Svartsengi data points

Due to the data collection of Svartsengi occurring late in the 2020 season, a subsequent round of cluster analysis (SPSS) was conducted to include these 2 new data points and used the same settings as the previous (fall 2020) analysis. Besides the inclusion of these 2 new points, which fell into category 12, the resulting dendrogram remained unchanged. Altogether, a total of 345 points were processed in this analysis. The final dendrogram and distinguished landscape groups are shown in Figure 30.

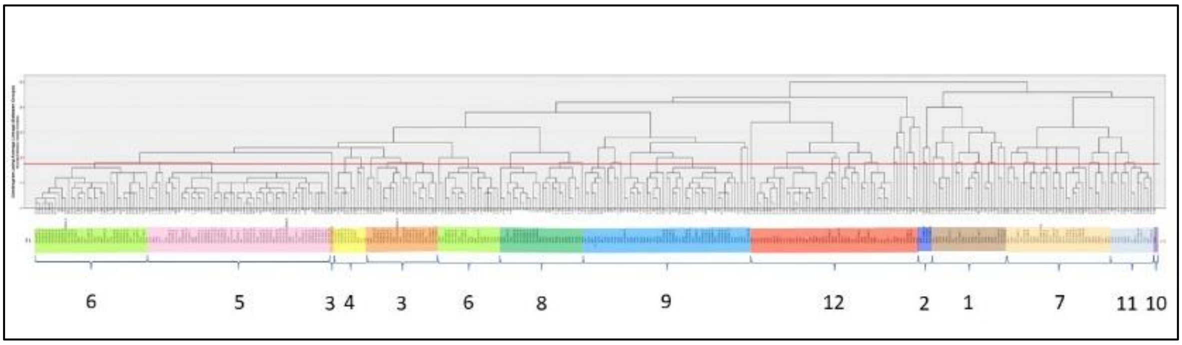

Fig. 30. Dendrogram and new landscape category grouping results from the most recent cluster analysis (SPSS) based on all data collection points to-date (345 points total). A general 'cut-off' height of about '9' (indicated by the RED line) was used to help determine logical divisions in the groupings

Figure 31 provides a spatial distribution of all 345 data point locations, color-coded by the latest landscape categories.

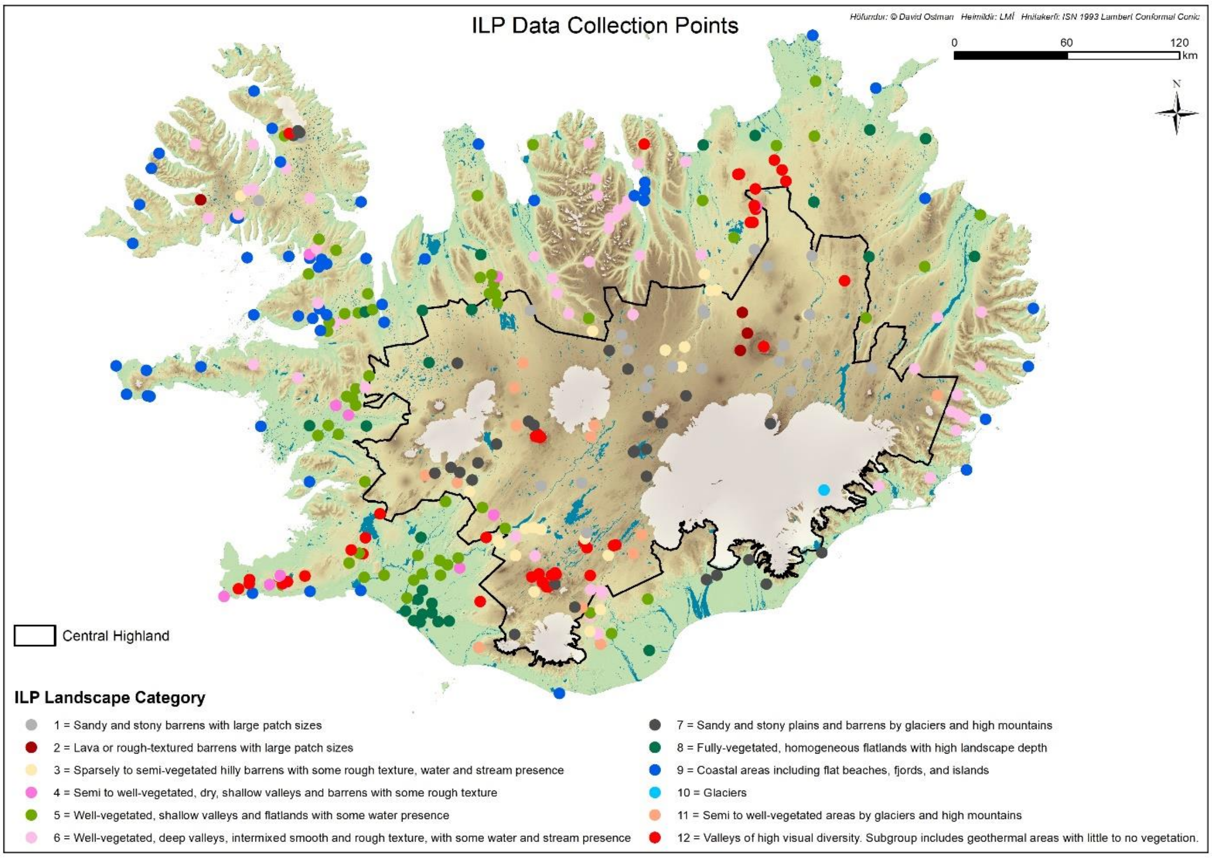

Fig. 31. Map showing all 345 data collection point locations color-coded by the 12 latest landscape categories