Report on 1st Hackathon

17 February 2025

Deliverable D3.2 (version 1.0)

Funded by
the European Union

Project name	**Transformation for sustainable nutrient supply and management**
Project acronym	**trans4num**
Project ID	101081847
Project duration	December 2022 – November 2026
Project Coordinator	University of Hohenheim (UHOH)
Project website	https://trans4num.eu/
Work package	3
Work package leader	AU
Deliverable number and title	3.2 Report on 1st Hackathon
Authors	Markéta Kollerová, Tomáš Mildorf, Karel Charvát
Version	1
Dissemination level	Public

Table of Contents

List of figures

List of tables

Executive summary

The first trans4num Hackathon, part of the EU-funded trans4num project, brought together 67 participants, including young farmers, students, researchers, and professionals to develop innovative nature-based solutions (NBS) for sustainable nutrient management. Following the INSPIRE Hackathon format, the event spanned several months, featuring an open call for challenges, a team-based problem-solving phase with expert mentorship, and a final evaluation. Out of 13 proposed challenges, 8 were accepted, covering topics such as AI-driven geospatial analysis, meteorological forecasting, and circular nutrient management. 7 challenges were successfully completed.

The final event, held on December 17, 2024, highlighted outstanding innovations. The top three projects were recognized for their impact and feasibility:

- Gold-winning team: Developed an agent-based modelling approach to evaluate NBS adoption in both Chinese and European agricultural contexts.
- Silver-winning team: Advanced AI-enhanced geospatial analysis to support rural development.
- Bronze-winning team: Created an interactive NBS demonstration toolkit for educational and practical implementation in sustainable farming.

The final reports and videos from all challenges are available online via: https://trans4num.eu/en/hackathon-2024/.

A key aspect of this hackathon was its international collaboration, with engagement extending beyond Europe. Notably, a challenge mentor from China actively contributed expertise to one of the challenges, offering valuable insights into sustainable agricultural solutions. The exchange of hackathon results with Chinese stakeholders reinforced the potential for deeper collaboration in future events.

The hackathon was supported by 12 mentors and evaluated by a jury of four experts, ensuring a structured and fair assessment process. Looking ahead to the next trans4num Hackathon in 2026, organizers aim to broaden international participation, particularly with the Chinese consortium, refine challenge selection, and introduce stronger incentives to enhance engagement and impact.

By fostering interdisciplinary cooperation and leveraging digital innovation, the trans4num Hackathon has laid a strong foundation for integrating NBS into modern agricultural practices, ultimately contributing to sustainable nutrient management, precision farming, and ecosystem resilience.

1. Trans4num introduction

The trans4num project is a four-year initiative funded under the EU's "Zero Pollution" call, emphasizing international cooperation between the European Union and China. Its primary focus is to leverage nature-based solutions (NBS) to tackle the challenges of nutrient management in agriculture. Coordinated by the University of Hohenheim, the project unites a diverse consortium of partners from 14 European countries and three regions in China. This collaborative effort integrates academic institutions, practice-oriented partners, and societal stakeholders, aiming to foster transformative change in agricultural practices.

Trans4num aspires to drive the widespread implementation of NBS across Europe through a multi-level, integrative approach. By engaging diverse actors and fostering dialogue, the project strives to:

- Identify and evaluate contextually suitable pathways for transforming agricultural nutrient management systems.
- Develop a user-oriented decision support tool for regional nutrient management.
- Generate practice-relevant insights into the potential of NBS for different agricultural systems, geographic regions, and climatic zones.
- Explore systemic farm-level, value chain, and food system dynamics to generate robust evidence for NBS adoption.

1.1 trans4num objectives

Trans4num seeks to broadly enhance the implementation of nature-based solutions through a comprehensive multi-level approach. Its primary goal is to develop and test innovative NBS practices and pathways that facilitate the transformation of intensive agricultural systems toward sustainable nutrient management. Specifically, the project aims to:

- Foster transformative learning and systemic research for sustainable agricultural practices.
- Advance the understanding of NBS potentials within intensive farming contexts.
- Analyze the complex interdependencies of NBS applications.
- Develop a dynamic nutrient management tool for informed decision-making.
- Provide integrated assessments of food systems, value chains, and policy leverage points for transitioning to NBS-based nutrient management.
- Disseminate evidence-based knowledge and create awareness to promote NBS implementation across farming systems.
- Strengthen Europe-China collaboration, enabling knowledge exchange and mutual learning.

1.2 Summary of the INSPIRE Hackathon format

The INSPIRE Hackathon is a collaborative and inclusive event format that brings together developers, researchers, designers, and other stakeholders who share an interest in open

data, volunteered geographic information (VGI), and citizen observatories. Originally launched during the 2016 INSPIRE Conference, the INSPIRE Hackathon has since evolved into a recurring platform for knowledge sharing, innovation, and networking. Supported by experts from European research and innovation projects, the hackathon highlights the power of modern technologies, common standards, and open data frameworks such as INSPIRE, Copernicus, and GEOSS.

Core Features of the INSPIRE Hackathon Format:

Collaboration across disciplines and sectors: The format emphasizes the engagement of diverse participants, including developers, data scientists, researchers, designers, and representatives from public and private sectors, to foster cross-disciplinary innovation.

Knowledge sharing and capacity building: A primary objective is to facilitate the exchange of knowledge and expertise among participants while raising awareness about the opportunities provided by open data and international data-sharing frameworks.

Focus on Open Data and Standards: The hackathon builds on the principles of the INSPIRE Directive and leverages related initiatives like Copernicus and GEOSS. By utilizing open data and standards, participants explore innovative solutions to real-world challenges.

Integration with research and innovation projects: Experts from EU projects provide mentorship and guidance, ensuring that hackathon challenges and outputs align with cutting-edge research and practical applications. This connection also strengthens the long-term impact of the event by integrating results into ongoing projects and activities.

Flexibility in implementation: In addition to the annual INSPIRE Conference, virtual hackathons are held at various venues throughout the year. These virtual events allow the hackathon format to be tailored to the needs and priorities of specific regions, topics, or projects.

Historical context and evolution:

The first INSPIRE Hackathon in 2016 focused on volunteered geographic information and citizen observatories. Encouraged by its success, the organizers continued this activity at the following year's INSPIRE Conference in 2017. Over time, the hackathon has expanded to include a broader range of topics and challenges, driven by emerging trends in data use and technological development.

The INSPIRE initiative serves as an umbrella framework for the hackathon format, enabling continuous contributions from European and international professional networks and projects, including H2020 and Horizon Europe initiatives. This dynamic and evolving structure ensures that each hackathon addresses relevant and timely challenges, while building on the foundational principles of interoperability, innovation, and collaboration.

By fostering a culture of shared learning and open innovation, the INSPIRE Hackathon has become a key tool for promoting the practical use of open data and advancing solutions that address pressing societal and environmental challenges.

1.3 Purpose and importance within the trans4num project

The hackathon was designed as an integral part of the trans4num project, serving as a dynamic platform to drive forward its objectives through collaborative innovation and interactive processes. The primary objective of the hackathon was to develop and test innovative Nature-Based Solution (NBS) practices and pathways that contribute to the socio-ecological transformation of intensive agriculture systems toward sustainable nutrient management.

Aligned with trans4num's ambition, the hackathon aimed to inspire young farmers, students, and professionals to engage in creating innovative business solutions using NBS technologies. It was also meant to promote international collaboration, particularly between the EU and China, leveraging the strengths and experiences of both regions to address pressing challenges in sustainable agriculture, nutrient management, and environmental health.

By engaging both internal collaborators from the trans4num team and external stakeholders, the event fostered a collaborative environment where project partners could refine and validate their approaches while benefiting from fresh perspectives and expertise from outside the consortium. This dual participation structure was essential to ensure that the developed Nature-Based Solution (NBS) practices were not only grounded in the project's scientific and technical foundations but also responsive to real-world challenges faced by practitioners, policymakers, and industry representatives. By opening the hackathon to a broader audience, the trans4num project facilitated cross-sectoral dialogue, strengthened stakeholder engagement, and enhanced the practical applicability of its outputs, ultimately increasing the impact and scalability of the proposed solutions.

While the hackathon successfully met many of its objectives within the European context, it also fostered international collaboration, including engagement with a challenge mentor from China. This mentor provided valuable expertise and insights, contributing to one of the hackathon challenges. While broader participation from Chinese partners was initially envisioned, their involvement in this phase primarily took the form of mentorship and post-hackathon exchange of results. This experience underscores the importance of flexible collaboration models in large international projects, ensuring meaningful contributions even when direct participation is constrained by differing resource allocations and priorities.

Despite these challenges, the hackathon remained focused on its core objectives:

1. **Develop innovative practices for sustainable nutrient management in agriculture**: Generate solutions focused on optimizing nutrient use efficiency, reducing environmental impacts, and promoting circular farming approaches within intensive farming systems.
2. **Promote ecosystem services enhancement and biodiversity in agriculture**: Develop solutions that enhance ecosystem services, improve biodiversity, and contribute to climate change mitigation within agricultural landscapes.
3. **Foster international collaboration for agricultural and environmental innovation**: While direct collaboration with China was not achieved in this phase, the hackathon

emphasized the importance of international cooperation to address shared challenges, drawing on the expertise of EU partners and leaving the door open for future joint activities.

1.4 Hackathon communication and cooperation with other projects

The first step in launching the trans4num Hackathon began with an initial presentation of the INSPIRE Hackathon format during the trans4num project meeting in Harpenden in June 2024[1]. This introduction provided consortium members with an overview of the hackathon structure, its objectives, and the role it would play in fostering innovation in sustainable nutrient management. Following this, discussions with HCC were initiated to define their involvement in the hackathon's visual identity and communication strategy. HCC took the lead in designing graphics and promotional materials while also coordinating the communication campaign across social media (https://www.linkedin.com/company/trans4num/posts/) and the project website (https://trans4num.eu/en/hackathon-2024/). See Annex 1 for more details.
In parallel, Plan4all actively promoted the campaign through its own network, utilizing the Plan4all website:

- https://www.plan4all.eu/inspire-hackathon/trans4num-inspire-hackathon-2024/
- https://www.plan4all.eu/2024/07/trans4num-inspire-hackathon-2024/
- https://www.plan4all.eu/2024/10/call-for-participants/

social media channels:

- https://www.facebook.com/plan4all, https://www.linkedin.com/groups/3374366/,

and personal outreach to maximize visibility and attract a diverse group of participants.

Besides that, continuous communication with the consortium was maintained to ensure broad engagement and support. Partners were regularly updated about the hackathon structure and timeline, and a Call for Challenges was issued, inviting them to propose relevant topics aligned with the project's goals. Beyond defining challenges, the consortium's active involvement was essential - not only as mentors guiding the hackathon teams but also as key mediators in engaging their networks. They were encouraged to bring in university students, farmers, and young professionals from their stakeholder communities, ensuring a diverse and dynamic participation in the hackathon.

[1] https://www.linkedin.com/feed/update/

trans4num INSPIRE Hackathon 2024

Posted on July 1, 2024 by Markéta Kollerová

Join us in driving innovation for sustainable agricultural nutrient management!

We are exited to announce that the **call for challenges for the trans4num INSPIRE Hackathon 2024 is now open!**

We are looking for **innovative challenge ideas focused on Nature-Based Solutions (NBS) for sustainable agriculture and land management!**

By **fostering collaboration between the EU and China,** the hackathon aims to inspire young farmers, students, and professionals to engage in creating innovative business ideas utilising NBS technologies.

This aligns with the broader ambition of trans4num to enhance NBS implementation through a multi-level approach involving academic partners, practice partners, and societal stakeholders.

This is a unique opportunity to contribute to the development of impactful solutions, work
with like-minded individuals from around the world, and benefit from the knowledge and experience of seasoned mentors.

Don't miss the chance to be part of this transformative event – submit your challenge today at https://trans4num.eu/en/hackathon-2024/submit-challenge/.

More details about the hackathon: https://trans4num.eu/en/hackathon-2024/

This entry was posted in News and tagged hackathon, inspire, inspire hack, inspire hackathon by Markéta Kollerová. Bookmark the permalink.

Figure 1: Initial article of Plan4all - Call for challenges

Figure 2: Official logo of the trans4num INSPIRE HACKATHON 2024

The trans4num Hackathon was enriched by active coordination with several European or national research and innovation projects, including PoliRuralPlus[2], ALIANCE[3], and AGRI-DIGITAL GROWTH[4]. These collaborations provided valuable expertise, datasets, and tools that shaped some of the challenges and supported the teams in achieving meaningful results. For instance, the PoliRuralPlus project contributed its Jackdaw tool, which offered a practical solution for analyzing rural development policies and strategies, and was incorporated into one of the hackathon challenges. This collaboration not only enhanced the technical depth of the hackathon but also demonstrated the potential for reusing tools and methodologies across projects to address shared goals related to sustainability and rural development.

The ALIANCE and AGRI-DIGITAL GROWTH projects also played pivotal roles. ALIANCE, with its focus on precision agriculture and the integration of artificial intelligence (AI) and remote sensing technologies, provided insights and data resources that guided the formulation of a challenge aimed at improving sustainable nutrient management.

Meanwhile, AGRI-DIGITAL GROWTH enhanced the visibility of the hackathon by inviting its project partners to participate, fostering broader engagement and collaboration.

These partnerships have clearly broadened the scope of the hackathon and also reinforced the trans4num project's commitment to working synergistically with other initiatives. By pooling resources, expertise, and networks, the hackathon highlighted the importance of interdisciplinary and multi-project coordination in achieving impactful outcomes.

In September 2024, Karel Charvat from Plan4all met with representatives from Tsinghua University, a partner in the trans4num project, to discuss opportunities for EU-China collaboration in Task 3.4. A key topic was the participation of Chinese partners and stakeholders in the second series of the trans4num Hackathon, aiming to enhance knowledge exchange and engagement in Nature-Based Solutions (NBS) for sustainable agriculture. This

[2] https://www.poliruralplus.eu
[3] https://aliance.hsrs.cz
[4] https://www.interreg-central.eu/projects/agri-digital-growth

discussion marked an important step toward integrating Chinese expertise and perspectives into the hackathon process, aligning with the broader objectives of the project.

Figure 3: Karel Charvát (Plan4all) meeting with Li Zhang (Tsinghua University)

2. Hackathon overview

The primary objective of the trans4num hackathon was to develop and test innovative Nature-Based Solution (NBS) practices and pathways that contribute to a socio-ecological transformation of intensive agriculture systems, driving more sustainable nutrient management. The hackathon was designed to engage a diverse audience, including young farmers, students, researchers, and professionals, and inspire them to generate innovative ideas and practical solutions using NBS technologies.

Aligned with the goals of **Task 3.4**, the hackathon served as a platform to connect technology developers, farmers, students, and investors, fostering collaboration and knowledge exchange across sectors. Through its interactive format, the hackathon promotes the development of innovative business ideas and solutions that address key challenges in sustainable agriculture. The event also supports transdisciplinary and multi-actor approaches by engaging stakeholders from diverse backgrounds, ensuring that solutions are both scientifically sound and practically applicable.

The hackathon reflects the central themes of **Task 3.4**, including:

- **Sustainable nutrient management**: Participants tackled challenges related to optimizing nutrient use efficiency, reducing environmental impacts, and promoting circular farming practices.
- **Biodiversity enhancement**: The event encouraged solutions that integrate NBS to enhance ecosystem services, improve biodiversity, and support climate change mitigation in agricultural landscapes.
- Interactive processes: The hackathon was structured as an iterative and collaborative process, inspired by the INSPIRE Hackathon methodology, where participants co-developed solutions through mentoring, expert guidance, and feedback loops. This dynamic approach ensured continuous refinement of ideas and fostered knowledge-sharing across disciplines.
- **EU-China collaboration**: While the planned collaboration with Chinese stakeholders faced challenges during this first hackathon, the broader goal of fostering knowledge exchange and joint innovation between the EU and China remains a guiding principle for the project. Efforts will be intensified to ensure more robust participation from Chinese partners in the next round of the hackathon in 2026.

The hackathon also lays the groundwork for **Task 5.2**, which will utilize its outputs to create communication materials, such as social media posts, short stories and videos, showcasing the challenges, innovative solutions, and results. This process amplifies the impact of the hackathon and demonstrates its contribution to the overarching goals of the trans4num project.

2.1 Call for challenges

The trans4num hackathon 2024 kicked off with a Call for Challenges, launched in June 2024 and remaining open until the end of September 2024. This phase was dedicated to gathering innovative ideas and problem statements aligned with the hackathon's primary focus on sustainable nutrient management, biodiversity enhancement, and Nature-Based Solutions (NBS) in agriculture.

The call invited consortium members, researchers, practitioners, students, and stakeholders from various disciplines to propose challenges addressing pressing issues in agriculture and nutrient management. By engaging a wide audience, the organizers ensured that the proposed challenges reflected diverse perspectives and addressed real-world needs.

During this period, participants submitted their ideas, which were then reviewed and refined by the organizing team to ensure they aligned with the hackathon's objectives. At the close of the call, eight challenges out of thirteen were finalized, each focusing on key themes such as nutrient optimization, ecosystem services, geospatial technologies, and innovative approaches to sustainability. These challenges were publicly announced, forming the foundation for participant engagement and solution development in the subsequent phases of the hackathon.

2.1.1. Challenges overview

As described by the mentors:

1. **Development of spectacular experimental and demonstration tools and content to establish and spread the use of NBS.**

   In many ways, the use of NBS improves ecosystem services and enhances biodiversity in agriculture. Since these NBS are usually implemented in a complex way, it is difficult to isolate the effects of the individual interventions, but the soil as a living system and some of its organisms are suitable for the role of an indicator. To demonstrate this, a mobile NBS Help Tools interactive demonstration kit has been developed, in several elements of which live earthworms are the indicator. NBS Help tools include the following tools: The centre desk- a tool for observation and problem raising: Challenges in agriculture –A painted Mock-up shows a detail of an agricultural landscape, where events and experiences related to non-NBS farming are graphically depicted in 8 themes. After the observer sees the mini-story related to each of the graphics displayed on the mock-up, he/she moves on to the soil 1-8 NBS 1. A tool to show the relationship between soil life and different levels of chemistry 2. The Soil Water Holding and Permeability Test 3. The Soil Compaction Tester 4. The Wind Effect Tool 5. The Soil Erosion Test Tool 6. The Soil Cover Crops Tool + Crop Rotation theme 7. Composting process demonstration tool 8. A model of the soil formation process with the Soil-dwelling microscopic organisms tool.
   Providing these tools with understandable and spectacular content is the first

task. The second task is to develop additional, newer tools and simpler, educational tools that can be used even in school education.
Mentors: Zoltán FŰZFA, PKE, Katalin MIHOLICSNÉ ORBÁN, PKE

2. **ALGAVERSE A Sustainable Food for Soil**

   ALGAVERSE will allow a novel route for sustainable food production for agriculture and horticulture by using microalgae biotechnology as an alternative to more costly and polluting conventional chemical fertilizers, also taking into account the need for climate-change resilient agricultural solutions. Our mission is to make innovative CO2-capturing Bio-Fertilizers derived from microalgal biomass that recover and recycle nutrients from waste streams, with the potential to provide solutions for food insecurity, energy crises and climate change. Our core mission is "Unlocking Carbon Removal: Paving the Way for Gigaton-Scale Solutions in the Fight Against Climate Change". Our vision is to reduce the agricultural greenhouse gas emissions from UK agricultural soil, which is estimated 47% methane, 68% nitrous oxide and 2% carbon dioxide, and to reduce the excess nutrient pollution of water bodies, due to excessive use of chemical fertilizers. What sets us apart from the competition is the use of novel microalgal-based processes, which give a viable, sustainable, and cost-effective solution to achieve safe and nutritional food production.
   Mentor: Nayab Raza, University of Manchester

3. **AI-Based Cloud-Free Crop Monitoring Challenge**

   This challenge invites the development of innovative solutions for crop monitoring, leveraging an advanced machine learning technology known as ALIANCE, which effectively removes clouds from satellite imagery. This enhancement significantly improves crop surveillance capabilities under adverse weather conditions. The approach integrates optical (Sentinel-2) and radar (Sentinel-1) data, which bolsters the model's robustness and precision in both image reconstruction and vegetation index assessments. This method is particularly advantageous for precision agriculture, which seeks to optimize outputs while minimizing inputs such as water, fertilizers, and pesticides. This challenge invites the development of innovative solutions for crop monitoring, leveraging an advanced machine learning technology known as ALIANCE, which effectively removes clouds from satellite imagery. This enhancement significantly improves crop surveillance capabilities under adverse weather conditions. The approach integrates optical (Sentinel-2) and radar (Sentinel-1) data, which bolsters the model's robustness and precision in both image reconstruction and vegetation index assessments. This method is particularly advantageous for precision agriculture, which seeks to optimize outputs while minimizing inputs such as water, fertilizers, and pesticides. The challenge also encourages the exploration of diverse data sources and their integration, including cloud-penetrating radar data and detailed spectral information from optical data. This integration is essential for continuous, precise monitoring of

crop conditions, independent of weather constraints.
Mentors: Petr Šimánek, Czech Technical University Prague, Jiří Kvapil, Lesprojekt-služby s.r.o.

4. **High-Precision Meteorological Forecasting Challenge for Optimizing Agriculture and Beyond**

   This challenge focuses on the development of revolutionary products that substantially enhance local meteorological forecast accuracy by utilizing the ALIANCE technology platform, which integrates data from both local and global meteorological measurements. This platform employs advanced machine learning techniques, such as multilayer perceptrons, CatBoost, and LSTM neural networks, to generate accurate weather forecasts, thereby boosting planning and management efficiency in agriculture and other sectors.
   ALIANCE is designed to be universally applicable to any meteorological measurements, making it a versatile solution for a variety of users. By combining local and global data sources, this technology achieves significant improvements in local forecast precision, essential for users relying on dependable and timely meteorological information.
   The development of a super-resolution model using state-of-the-art deep learning architectures enables ALIANCE to provide high-resolution forecasts in nearly real-time. This capability ensures that users can quickly respond to changing weather conditions, which is critical for minimizing risks and optimizing operations.
   While the primary focus is on the agricultural sector, the applications of ALIANCE extend beyond this industry. It is anticipated to be beneficial in areas where accurate and reliable weather forecasts are crucial, such as crisis management, construction, and logistics. This versatility allows clients to employ ALIANCE across various applications, enhancing its value and utility.
   ALIANCE is designed to significantly improve the local accuracy of meteorological forecasts and serve as a crucial tool for anyone requiring precise and current weather data for effective decision-making. It offers an ideal solution for those aiming to maximize the benefits of accurate forecasts in their operational strategies and planning.
   Mentors: Miroslav Čepek, Czech Technical University Prague, Michal Kepka, Baltic Open Solutions Center

5. **AI-Enhanced Geospatial Analysis for Rural Development Challenge**

   This challenge aims to foster innovative applications of AI in rural development by combining large language models (LLMs) with geospatial analysis, an approach termed GeoAI. Participants are encouraged to utilize both existing LLM platforms and to develop their own models on our provided infrastructure to address rural development needs effectively.
   The challenge focuses on harnessing the synergistic potential of LLMs with geospatial data to offer sophisticated insights and solutions that can directly impact rural areas. By integrating these technologies, the challenge seeks to

enhance decision-making processes, improve resource allocation, and increase the overall effectiveness of rural development strategies.
Participants will explore how advanced AI models can be integrated with geographic information systems (GIS) to analyze spatial data more effectively. This integration aims to provide comprehensive solutions that address various aspects of rural development, such as agricultural efficiency, land use planning, and infrastructure development.
Mentors: Alexander Kovalenko, Czech Technical University Prague, Karel Charvát, Lesprojekt-služby s.r.o.

6. **Web-Scraping for NBS**

   Part of trans4num is about upscaling NBS, regional nutrient balances and food-system level assessment. Doing this requires large amounts of detailed data on, for example, nutrient contents of various crop parts (used as organic fertilizer), feed nutrient characteristics of various commodities and by-products (to capture the livestock part in systems with large-scale NBS implementation) and food nutrient characteristics of the commodities to assess the contribution to feeding the population. Much of this data is available in scattered sources - scientific papers, reports, and websites - but in a form that is not readily accessible and useful for modelling. The challenge would be to program web-scraping code that allows to automatically extract this relevant information from a variety of different sources and store it in a standardised form ready for use in the models on the food system level and for regional nutrient balances.
   Mentor: Adrian Müller, FiBL
   Note: due to the complete lack of participants this challenge was cancelled.

7. **Regional nutrient balances for better decisions towards nutrient circularity**

   Nature-based solutions in trans4num aim to improve nutrient circularity on a regional scale. With regional nutrient balances the effectiveness of NbS towards this goal can be assessed. However, calculating such balances with existing models, often based on national or sub-national data, is subject to a rather high degree of uncertainty for a given case study region. Ultimately, the outcome of the challenge will feed into a decision-support tool for local stakeholders and decision-makers.
   Mentors: Hanna Frick, FiBL

8. **Fundamentally different case studies of nature-based solutions - how can they be integrated into a common agent-based modelling approach?**

   Nature-based solutions (NBS) are developed at the local level but must be transferable - to other societies, other places, and other contexts. The success of the adoption of NBS depends on their acceptance by the farming community, while innovation also occurs through scalability and transferability. Current research focuses not only on NBS case studies themselves, but also on the diffusion process, stakeholder acceptance and

adoption of NBS implementation. The challenge in modelling is to achieve a degree of flexibility while managing complexity. For this, a joint Chinese-European agent-based model specification plan is needed to provide a framework for ex-ante impact assessment to evaluate the (net) effects of adopting technological and social innovations based on NBS in both Chinese and European settings. The joint model specification plan should include solutions for working with modular structures, limited data availability, and changing agent types, but also with different dissemination.
Mentors: Anke Möhring, FiBL, Yuqua Chen, CAU

The Call for Challenges phase played a pivotal role in shaping the hackathon, establishing a clear framework for participants to tackle meaningful issues while contributing to the broader goals of the Trans4num project.

2.2 Call for Participants

Following the definition of challenges, the Call for Participants was launched to engage a diverse group of innovators, researchers, students, and professionals interested in addressing the identified issues. The call was widely disseminated through multiple channels during the period of October-November 2025, including the trans4num project website, the Plan4all[5] website, and various social media platforms. To support outreach, HCC designed dedicated graphics (Annex 1) that enhanced the campaign's visibility and engagement. Regular updates and reminders ensured continuous visibility and encouraged participation from a broad audience. Outreach efforts targeted universities, research institutions, startups, and industry professionals, ensuring a mix of backgrounds and skills within the teams.

The campaign attracted over 20 participants from outside of the project, bringing together individuals with expertise in agriculture, geospatial technologies, data science, environmental science, and business development. In addition to those who joined through the open call, additional participants were directly approached through the networks of mentors and were actively involved during the hackathon process. Overall, there were more than 50 participants engaged in the challenges.

[5] https://www.plan4all.eu/2024/10/call-for-participants/

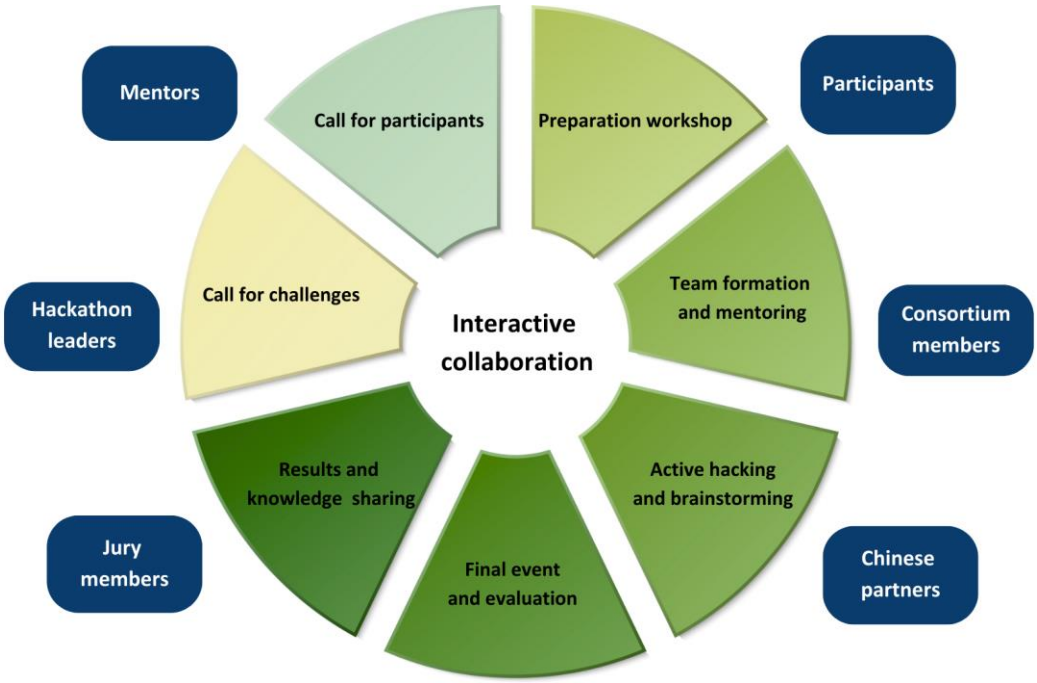

Figure 4: Hackathon process

Participants were given the opportunity to choose one or multiple challenges from the predefined list based on their interests and expertise. This approach allowed for flexibility in forming teams, ensuring that challenges were supported by motivated participants.

To facilitate collaboration, participants were then organized into teams according to their chosen challenges. Each team was led by respective mentors and encouraged to engage in an iterative problem-solving process. As the hackathon was conducted remotely, teams leveraged online communication tools such as video calls, shared documents, and messaging platforms to collaborate effectively throughout the event. This setup enabled seamless coordination, allowing participants to contribute regardless of their geographical location.

2.3 Preparation workshop

Before the hacking phase officially began, mentors participated in a dedicated workshop on 25th September 2024 to familiarize themselves with the hackathon process, their roles, and expectations. The workshop was designed to ensure that mentors could effectively support participants and guide them toward successful outcomes.

During the session, mentors received an overview of the trans4num project and its focus on sustainable nutrient management through Nature-Based Solutions (NBS). They were introduced to the finalized list of challenges, along with an explanation of the key objectives and expectations for each. A structured hackathon timeline was also presented, detailing critical milestones such as the opening of participants' registration (1st October 2024), the hacking period (21st October – 30th November 2024), and final report submissions (by 7th December 2024).

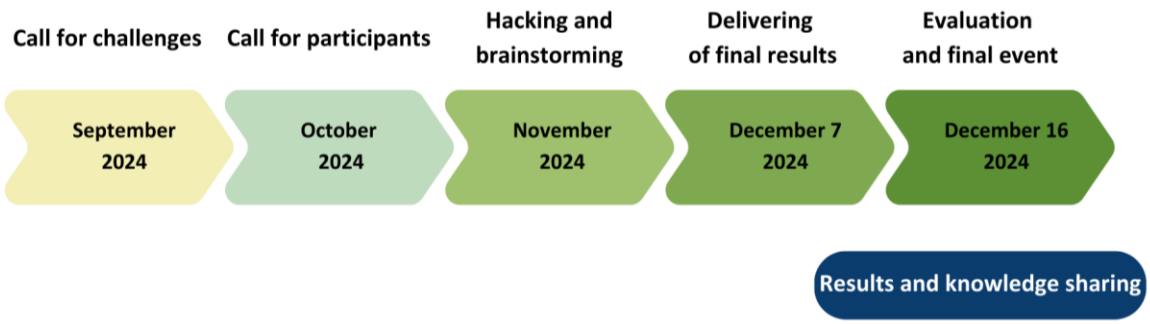

Figure 5: Structured hackathon timeline

Mentors were tasked with coordinating teamwork and communication, organizing virtual meetings, and supporting the development of final reports, presentations, and short video clips showcasing the hacking process. By the end of the workshop, mentors had a clear understanding of their responsibilities, the support available to them, and the expectations for guiding teams toward impactful solutions. Moreover, mentors were provided with a document Guidelines for Mentors[6], presentation[7] and later a video recording from the webinar summarizing their roles and tasks over the process.

To foster an interactive and dynamic team environment, mentors were encouraged to leverage collaborative tools such as video conferencing platforms (Zoom, Microsoft Teams, Skype), instant messaging (Slack, Skype chats), and shared digital workspaces (Google Drive, Microsoft Sharepoint). This approach ensured that teams remained engaged, well-coordinated, and able to iterate their ideas in real time, even when working remotely.

2.4 Hacking phase

Mentors played a crucial role in guiding participants through the hackathon process. Each challenge was supported by one or more mentors, who provided technical insights, domain knowledge, and methodological support throughout the event.

At the start of the hackathon, mentors introduced the challenges in detail, helping participants understand the scope, key objectives, and expected outcomes. During the problem-solving phase, they actively engaged with teams by answering questions, clarifying concepts, and suggesting relevant tools or data sources.

Mentors were available via online communication channels, offering both scheduled check-ins and on-demand support. Some mentors also connected participants with external experts or resources that could enhance their solutions. Additionally, several mentors brought

[6] Available at: trans4num_INSPIRE Hackathon 2024_Guidelines for mentors.docx

[7] Available at: trans4num_presentation mentors meeting 25092024.pdf

participants from their own professional networks, further enriching the hackathon with diverse perspectives and real-world insights.

2.5 Jury and evaluation

The jury played a crucial role in evaluating the hackathon results and ensuring a fair selection of the winning teams. Their engagement was structured in three key phases: preparation, participation during the final event, and the announcement of winners.

The jury for the trans4num Hackathon 2024 comprised distinguished professionals with diverse expertise:

- **Tuula Löytty**: CEO of Smart & Lean, Tuula holds an MSc in Industrial Engineering and Management from Lappeenranta Technical University and a Bachelor's in Process Technology from Satakunta University of Applied Sciences. With 18 years in the private sector and 18 years in higher education, she is a certified Lean Six Sigma Black Belt and Lean-Sensei, specializing in enhancing business processes through lean methodologies.
- **Forough Khajehei**: Serving as a Project Officer at the Hohenheim Research Center for Global Food Security and Ecosystems, Dr Khajehei completed her Bachelor's and Master's degrees in agricultural engineering with a focus on food science and technology at Shiraz University in Iran. She earned her doctorate in Agricultural Science from the University of Hohenheim in Germany.
- **Martin Tuchyňa**: After graduating from the Technical University in Zvolen, Martin has been working at the Slovak Environmental Agency since 2000. He specializes in geoinformatics and its standardization, focusing on activities related to building and operating infrastructures for spatial information and eGovernment.
- **Radovan Hilbert**: As a key figure at YMS, Radovan has been instrumental in developing innovative solutions for agriculture, including projects that analyze satellite data to assess field conditions and provide precise evaluations for crop management.

Preparation for the Final Event
Before the event, jury members were required to review the final reports and presentations submitted by the teams. Each submission included a detailed report and a video presentation, except for Challenge Nr. 7, where the mentor decided to present the solution live in case of a winning placement. To ensure an efficient evaluation process, jury members were provided with a structured evaluation form. The scoring system ranged from 1 to 5 points across multiple categories, including innovation and creativity, impact and sustainability, feasibility and practicality, collaboration, and presentation quality, ensuring a fair and structured assessment of all submitted solutions.

1. **Innovation and creativity**: This criterion assessed how novel and inventive the proposed solution was in addressing the hackathon challenges. The jury considered:

- New methods, tools, or approaches: Did the team introduce an original concept, or did they adapt existing technologies in an innovative way?

- Forward-thinking and originality: Does the solution bring fresh ideas to the field of sustainable nutrient management and ecosystem services?
- Creative problem-solving: Did the team demonstrate an ability to think outside the box in overcoming challenges related to agriculture and environmental sustainability?

2. Impact, sustainability, and practicality: This category measured the potential real-world applicability of the solution, focusing on both environmental and economic aspects. The jury examined:

- Optimization of nutrient use efficiency: Does the solution reduce fertilizer waste and improve soil health?
- Environmental impact reduction: Does it help minimize pollution, prevent soil degradation, or reduce greenhouse gas emissions?
- Promotion of circular farming approaches: Does it integrate closed-loop agricultural practices, such as waste reuse or resource efficiency?
- Biodiversity and climate change mitigation: Does it encourage biodiversity conservation and contribute to climate resilience?
- Technical and economic feasibility: Can the solution be realistically implemented within current agricultural systems? Is it affordable for farmers and agribusinesses?
- Scalability and adaptability: Can the approach be expanded to different farming systems, geographic regions, or climatic conditions?

3. Presentation and clarity: This criterion focused on how well the team communicated their work through their video presentation and final report. The jury assessed:

- Clear and structured explanation: Are the objectives, methodology, and results logically presented?
- Understandability: Can a non-expert understand the key points of the solution?
- Professionalism and engagement: Is the presentation compelling, well-prepared, and visually effective?

Completing this form ahead of the event helped streamline the selection process during the final deliberations.

After completing individual evaluations, the jury convened in a deliberation session to discuss and finalize the ranking of the teams. A consensus-based approach was used to select the top three winners - Gold, Silver, and Bronze - based on total scores and qualitative feedback.

This structured approach ensured a fair, transparent, and well-organized evaluation process, recognizing the most impactful solutions while fostering a valuable learning experience for all participants.

2.6 Final event

The trans4num INSPIRE Hackathon 2024 Final Event was held on December 17, 2024, providing a platform for participating teams to present their innovative solutions to a panel

of esteemed jurors and the trans4num consortium. Each team submitted their final report, presentation and video presentation summarizing their challenge, proceedings and results.

The event commenced with opening remarks from the organizers, setting the stage for the presentations and outlining the agenda. Each team was allocated time to showcase their projects, detailing their approaches to the predefined challenges. Presentations of each challenge highlighted the problem statements, methodologies employed, solutions developed, and potential impacts.

Following each presentation, jurors engaged with the teams through a Q&A session, probing deeper into the projects to assess their feasibility, innovation, and applicability. After all presentations, the jury convened in a 20-minute private session to evaluate the projects based on predefined criteria, including innovation, impact, feasibility, collaboration, and presentation quality where they finalized their rankings and determined the Gold, Silver, and Bronze winners.

The event concluded with the announcement of the top teams, recognizing their exceptional contributions and innovative solutions.

Gold - Anke Möhring, Yuquan Chen - Fundamentally different case studies of nature-based solutions - how can they be integrated into a common agent-based modelling approach? Final report, check the video.

Silver - Karel Charvát, Alexander Kovalenko - AI-Enhanced Geospatial Analysis for Rural Development Challenge Final report, check the video.

Bronze - Zoltán Füzfa, Katalin Miholicsné Orbán - Development of spectacular experimental and demonstration tools and content to establish and spread the use of NBS Final report, check the video.

Recording from the Final Event is available here: trans4num INSPIRE Hackathon 2024 - Final Event.

The winning teams were issued certificates for their outstanding work and dedication during the hackathon process. See Annex 2.

3. Results and Impact

3.1 Summary of solutions proposed by the teams and connection to project objectives

The results from the trans4num hackathon challenges (available at: https://trans4num.eu/en/hackathon-2024/) are closely aligned with the overall objectives of the trans4num project, which aims to foster digital transformation and sustainable practices in agriculture and rural areas. Here's how each challenge contributes to achieving these objectives.

Challenge 1: Development of spectacular experimental and demonstration tools and content to establish and spread the use of NBS.

Number of participants: 30
The development and implementation of the "NBS Help Tools" interactive kit significantly advanced educational strategies regarding sustainable farming. This toolkit includes tools for soil compaction testing and erosion simulation, making it a hands-on educational resource that not only informs but also engages users in the practical application of Nature-Based Solutions. These tools directly contribute to trans4num's goal of enhancing environmental awareness and sustainability in agricultural practices.

Challenge 2: ALGAVERSE A Sustainable Food for Soil

Number of participants: 4
The BHAAN project successfully developed a bio-fertilizer from algae, which proved to reduce soil salinity and increase crop yields during trials. This product aligns with the project's emphasis on reducing chemical inputs and showcases a viable, sustainable alternative that enhances soil health and supports carbon sequestration. These results contribute to the broader objective of fostering environmentally sustainable agricultural methods within the project's framework.

Challenge 3: AI-Based Cloud-Free Crop Monitoring Challenge

Number of participants: 4
This challenge leveraged artificial intelligence to effectively remove cloud cover from satellite imagery, ensuring uninterrupted crop monitoring. The result is a reliable, clear view of crop health regardless of weather conditions, facilitating better crop management and decision-making. This innovative use of AI in overcoming data acquisition barriers directly enhances agricultural productivity and resource efficiency, core aims of the trans4num project.

Challenge 4: High-Precision Meteorological Forecasting Challenge for Optimizing Agriculture and Beyond

Number of participants: 4
By integrating local weather data with global models and historical data, the challenge significantly improved the accuracy of short-term weather forecasts. These enhanced forecasts allow farmers to make more informed decisions about planting, irrigation, and harvesting, leading to improved yield management and reduced resource wastage—key

outcomes that support the project's objective of integrating digital tools for better agricultural outcomes.

Challenge 5: AI-Enhanced Geospatial Analysis for Rural Development Challenge

Number of participants: 10
The Jackdaw platform, further developed under this challenge, integrates AI with geospatial analytics to streamline decision-making in rural infrastructure and agricultural planning. It effectively addresses logistical challenges such as resource allocation and land use planning, providing targeted, actionable insights that bolster rural development - a fundamental aspect of the trans4num project's goals.

Challenge 7: Regional nutrient balances for better decisions towards nutrient circularity

Number of participants: 2
This challenge's development of a model for calculating regional nutrient balances provides vital data for enhancing nutrient management across various scales. By facilitating a more efficient use of resources and promoting nutrient recycling, this model aids in achieving sustainable nutrient management practices, contributing to the project's focus on promoting circular economy principles in agriculture.

Challenge 8: Fundamentally different case studies of nature-based solutions - how can they be integrated into a common agent-based modelling approach?

Number of participants: 13
The agent-based model developed in this challenge provides a sophisticated tool for evaluating the adoption and impact of Nature-Based Solutions across different agricultural settings. This model allows for the simulation of various scenarios to understand the potential benefits and challenges of NBS, enabling stakeholders to make informed decisions about implementing sustainable agricultural practices. This detailed modeling approach exemplifies the project's commitment to fostering innovation and sustainability through digital transformation.

Total submitted challenges	13
Total approved challenges	8
Total completed challenges	7
Total mentors	12
Total hacking participants	67
Total jurors	4

Table 1: Hackathon participants overview

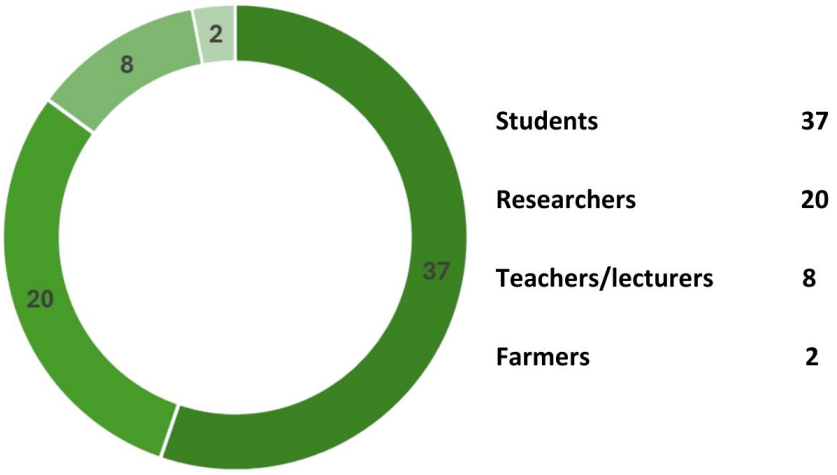

Figure 6: Categories of hackathon participants

3.2 Broader implications for sustainable agriculture and biodiversity.

The trans4num hackathon directly advanced the objective of developing and testing innovative Nature-Based Solution (NBS) practices and pathways to drive the socio-ecological transformation of intensive agriculture systems. By fostering an interactive, challenge-based format, the hackathon enabled participants to co-create solutions through expert mentorship, iterative refinement, and cross-disciplinary collaboration, ensuring that the proposed ideas were both innovative and practically applicable.

The results from the hackathon showcase a strong alignment between digital innovation and ecological sustainability, demonstrating how technology-enhanced NBS approaches can support sustainable nutrient management, biodiversity preservation, and climate resilience. The NBS Help Tools, for instance, illustrate the power of hands-on educational resources in promoting awareness and adoption of sustainable farming techniques. Similarly, the BHAAN bio-fertilizer provides a concrete example of how algae-based solutions can improve soil health while reducing dependency on synthetic inputs.

The AI-based cloud-free crop monitoring system exemplifies how advanced digital tools can enhance real-time agricultural decision-making, reducing inefficiencies and preventing resource overuse. Likewise, the agent-based modelling approach developed during the hackathon offers a robust framework for assessing the adoption and impact of NBS across diverse agricultural contexts, allowing stakeholders to simulate potential outcomes before full-scale implementation.

Moreover, the interactive process of the hackathon, modelled after the INSPIRE Hackathon methodology, ensured that teams engaged in continuous knowledge exchange, real-world testing, and adaptation of ideas, leading to high-impact solutions. The diverse range of challenges—from precision meteorological forecasting to regional nutrient balance

modelling—demonstrates the transformative potential of digital and nature-based innovations in advancing the goals of the trans4num project.

Overall, the hackathon has reinforced the importance of multi-actor collaboration and cross-sectoral engagement in shaping the future of sustainable agriculture. By integrating cutting-edge technology with ecological consciousness, the outcomes contribute to reducing environmental impact, enhancing biodiversity, and promoting circular nutrient management, positioning NBS as a viable pathway for achieving long-term sustainability in agriculture.

3.3 Next hackathon - cooperation with the Chinese consortium

For the 2026 hackathon, we are aiming to intensify cooperation with the Chinese consortium, while exploring both virtual and on-site participation models that offer diverse benefits and challenges. Inviting Chinese partners to join teams virtually may ensure inclusivity and continuous collaboration, allowing for a broad range of expertise and perspectives to merge without the limitations imposed by travel. This model offers flexibility for participants to balance other commitments. However, virtual collaboration can sometimes limit the depth of interpersonal relationships and may face challenges such as time zone differences and dependency on reliable technology.
Organizing an in-situ hackathon during the project's General Assembly in 2026 may provide the invaluable benefit of face-to-face interaction, which can enhance team dynamics, spur spontaneous innovation, and facilitate intense, focused work sessions. This model also fosters a rich cultural exchange and builds strong, personal bonds that are crucial for long-term international cooperation.

3.4 Limitations and implications

The first trans4num hackathon highlighted several limitations and implications that provide important learning opportunities for future iterations. Here's a nuanced exploration of these challenges:

1. Alignment with project objectives: While the hackathon aimed to foster broad engagement and innovation by incorporating external challenges, this approach resulted in a perceived misalignment with the trans4num project's specific goals. This disconnection was particularly noted by consortium members who expected a stronger focus on the project's core objectives. Future hackathons will benefit from a more rigorous selection of challenges that are directly linked to the project's aims, ensuring that all activities contribute meaningfully to the project's outcomes.

2. Challenge engagement and participation: One stark example of engagement issues was Challenge Nr. 6, which was not proceeded with due to a complete lack of participants. This situation underscores the critical need for better alignment of challenge topics with participants' interests and expertise, ensuring that all challenges are capable of attracting and retaining adequate and appropriate engagement.

3. Consortium engagement: The engagement level among consortium members, especially from Chinese partners, was lower than anticipated. Initial plans for a more integrated involvement fell through, which impacted the overall collaboration and the hackathon's objective to strengthen EU-China relations. This issue underscores the need for more robust mechanisms to ensure active participation from all consortium members, possibly through more compelling incentives and clearer communication of the benefits and expectations.

4. Participant expertise and expectations: A significant gap between the expectations of mentors and the expertise of participants was observed. Some challenges attracted participants who lacked the necessary background to contribute effectively, which led to frustration and reduced productivity. To address this, future hackathons should implement a more stringent participant vetting process to match skills and expertise with the hackathon's needs. Additionally, setting clear expectations for participation and outcomes will help align mentors' and participants' goals.

5. Incentives and motivation: Motivating participants to engage deeply with the hackathon's challenges were identified as a concern. Although we did have a prize sponsored by the University of Hohenheim, it was not heavily advertised due to its last-minute confirmation. While budget constraints typically limit our ability to offer substantial rewards, the unexpected availability of a prize this time highlights the potential impact of such incentives on participant motivation. Going forward, we aim to better integrate and promote such opportunities, alongside emphasizing professional development, networking opportunities, and recognition to enhance participant engagement. This approach will ensure that all potential motivators are effectively utilized to attract and retain participants' interest and commitment to the hackathon.

6. Process and event structure: The structure of the hackathon, encouraging participants to engage in multiple challenges, was criticized for diluting the focus and commitment. Moving forward, it may be beneficial to limit participants to single challenges to ensure deeper and more focused contributions.

These reflections suggest a need for a structured review and adaptation of hackathon planning and execution strategies. By addressing these limitations, the trans4num project can enhance the effectiveness and impact of future hackathons, ensuring they not only meet the expectations of all participants but also drive forward the project's overarching goals.

4. Annexes

4.1 Annex 1 - Graphics for hackathon promotion

Figure 7: Set of graphics created by HCC for hackathon promotion

Figure 8: Set of graphics created by HCC for promotion of each hackathon challenge

4.2 Annex 2 - Certificates issued for hackathon winners

Figure 9: Certificate for Anke Möhring, the leader of the Gold-winning team[8]

[8] Each member of the winning team was issued a personalised certificate

Figure 10: Certificate for the Silver awarded team

Figure 11: Certificate for the Bronze awarded team