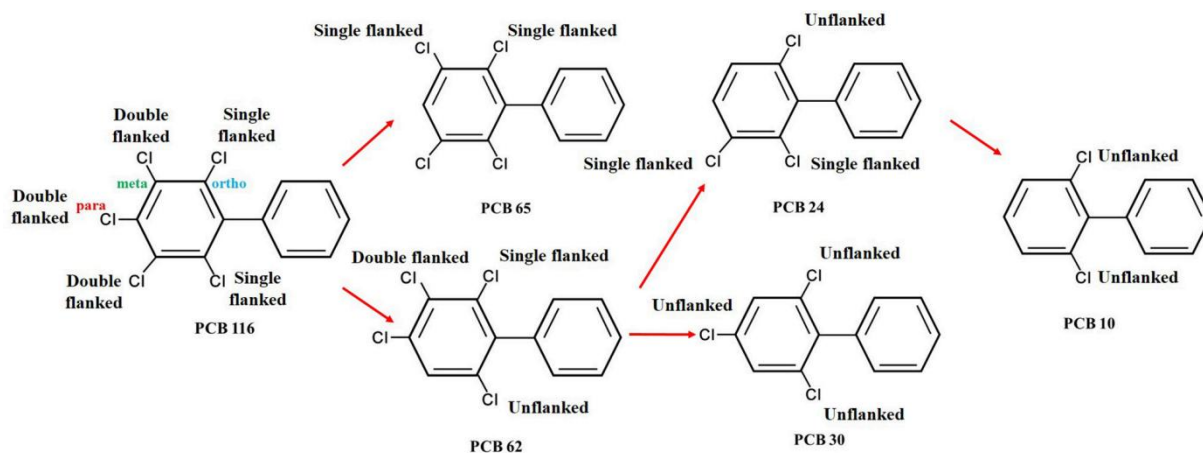




Management of POPs Risks in the Context of Transition to a Sustainable Bioeconomy (Acronym: POPs_RISKMANbase)

Annex WP4 D4.4

Report title and designation:	D4.4	Final public report		
Work Package	WP4/KPB4			
Responsible project partner:	TUKE	Workplace:	Faculty of Aeronautics	
Deliverable due date	M30	Delivery date:	August 2026	
Deliverable approval:	TUKE	Name:	Hana Pačaiová Michal Hovanec	
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Version:	I.	Date of change:		
Deliverable type (report):	public	final	interim	other
	x	x		



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Summary of the Task Addressed

Final report D4.4 summarizes the implementation of the project Management of POPs Risks in the Context of Transition to a Sustainable Bioeconomy over its entire implementation period. The report provides a public summary of the project objectives, activities implemented, completed work packages, deliverables achieved and the project's main contributions.

The project aimed to establish a knowledge base and holistic methodological support, C&HMS/PCBRISKMAN, for the analysis, assessment and management of risks associated with persistent organic pollutants, especially PCBs. The project deliverables established a connected system from source identification and critical scenarios, through methodology, GIS and model-framework design, to verification, assessment of measures, calculation of residual risk and a proposal for further development of the decision platform.

The report also summarizes the project-management approach, research-data management, use of the project website, dissemination activities and prospects for further use of the results in applied research, public administration and environmental remediation.

Introduction

The project Management of POPs Risks in the Context of Transition to a Sustainable Bioeconomy focuses on research, assessment, and support for the management of environmental risks associated with persistent organic pollutants, especially polychlorinated biphenyls. PCBs represent a long-term environmental burden that persists in environmental media, binds to sediments, soil, organic matter, and biota, and may affect public health, the food chain, land use and the development of affected regions.

The project objective was to establish a knowledge base and comprehensive holistic methodological support, C&HMS/PCBRISKMAN, enabling the systematic identification of PCB sources, assessment of their transport pathways, evaluation of receptor vulnerability and support for decisions on monitoring and mitigation priorities. The project was conceived as an interdisciplinary solution linking environmental engineering, risk management, analytical and monitoring approaches, GIS processing, risk modelling, technical-economic assessment, and digital decision support.

Project implementation was divided into four work packages:

- Work package WP1/KPB1 – Analysis established analytical foundations for identifying sources, transport pathways, receptors, and critical scenarios.
- Work package WP2/KPB2 – Methodology developed these findings into a methodological, data, modelling and GIS framework for POPs/PCB risk assessment.
- Work package WP3/KPB3 – Verification built on the preceding results by preparing a verification framework, checking the PCBRISKMAN model, proposing measures, calculating residual risk, and designing a framework for further research.
- Work package WP4/KPB4 – Management and Dissemination ensured project management, partner coordination, data management, preparation of public deliverables and communication of results to the professional community and wider public.

This final D4.4 report summarizes project implementation in a public format. Its purpose is to provide a clear overview of project delivery, completed work packages, deliverables achieved, main technical contributions and opportunities for further use of the results. The report does not replace the detailed technical deliverables of individual work packages; rather, it provides their consolidated final assessment from the perspective of overall project implementation.

The report was prepared as the final public deliverable of work package KPB4, taking account of the approved change to the project schedule, under which substantive project implementation was completed in August 2026 and work package KPB3 – Verification was completed at M32. For this reason, the report also includes a summary of KPB3 results, which represent the final technical part of the project.

1. Project Objective and Implementation Framework

The main objective of the project was to establish a knowledge base and methodological support for managing POPs risks, primarily PCB risks, in the context of the transition to a sustainable bioeconomy. The project focused on linking source identification, assessment of transport pathways, evaluation of receptor vulnerability, risk modelling and the design of risk-reduction measures.

Project implementation followed a logical sequence from the analytical phase through methodological design to verification and final assessment. In the first phase, analytical foundations were established, and critical scenarios identified. In the second phase, the methodological, data, modelling and GIS framework was developed. In the third phase, verification, control, and application-oriented elements of the PCBRISKMAN model were prepared and evaluated. The fourth work package ensured management, data management, public communication, web presentation and the final summary of results.

The framework developed in this way supports a shift from simply recording environmental burdens to active risk management. Its essence is the ability to determine which PCB source has priority, through which mechanisms risk spreads, which measures are appropriate and what residual risk remains after their implementation.

2. Project Activities Implemented

Project activities were implemented in accordance with the approved work-package structure and the currently applicable project schedule. Individual activities were oriented towards establishing the comprehensive C&HMS/PCBRISKMAN framework and its applicability to POPs/PCB risk assessment and management.

- collection, classification, and professional assessment of knowledge on PCB sources, properties, transport and effects in the environment,
- identification of primary and secondary contamination sources, transport pathways, receptors and critical scenarios,
- design of a static-dynamic model framework for assessing probability, consequences, and risk level,
- development of requirements for measurement, collection, management, and quality of data usable in the model and GIS environment,
- design of the use of GIS tools, risk maps and spatial interpretation of results,
- preparation of the PCBRISKMAN model verification framework, including checkpoints, QA/QC and uncertainty assessment,
- checking the logical and computational consistency of the model, selection of measures and calculation of residual risk,
- completion of the measures catalogue, reduction factor RF and design of technical-economic CAPEX/OPEX inputs,
- design of further model development towards GIS, heat-map visualization, CBA/MCDA and decision support,
- ensuring project management, partner communication, data management, the project website, and public deliverables.

Interdisciplinary approaches were used, linking environmental engineering, risk management, analytical chemistry, GIS, aviation and unmanned technologies, risk modelling, technical-economic assessment, data management and decision support.

3. Project Results Achieved

Technical and public deliverables for work packages WP1/KPB1 to WP4/KPB4 were prepared within the project. These deliverables are substantively linked and together create a coherent system from problem analysis, through methodology design and modelling, to verification, assessment of measures, dissemination, and the project's final public summary.

KPB1 deliverables established analytical foundations for identifying and assessing PCB sources. KPB2 deliverables developed the measurement, data, modelling and GIS framework. KPB3 deliverables prepared a verification framework, checked computational logic, developed a measures catalogue, calculated residual risk and designed a framework for further research. KPB4 deliverables ensured project management, data management, web presentation, the public implementation summary and dissemination of results.

3.1 Overview of Completed Work Packages and Project Deliverables

An overview of completed work packages and their main deliverables is provided in Table 1.

Table 1 Overview of completed project work packages and deliverables

Work Package	Main focus	Completed deliverables	Result
WP1/KPB1 – Analysis	Identification of sources, transport pathways, receptors, and critical scenarios	D1.1 – D1.6	Analytical foundation and PCB risk assessment concept established.
WP2/KPB2 – Methodology	Measurement, data, modelling and GIS framework for risk assessment	D2.1 – D2.6	Methodological and modelling PCBRISKMAN framework established.
WP3/KPB3 – Verification	Preparation for verification, model checking, measures, and residual risk	D3.1 – D3.4	Framework for verification, assessment of measures and further research established.
WP4/KPB4 – Management and Dissemination	Project management, data, website, public deliverables, and dissemination	D4.1 – D4.7	Coordination, data management, web communication and final publication of results ensured.

The project also achieved its main milestones, documenting progress from defining critical scenarios through methodology design to verification of the methodological framework (Table 2).

Table 2 Status of achievement of the main project milestones

Milestone	Name	Means of achievement	Status
M1	Critical Scenarios Defined	WP1/KPB1 deliverables, particularly D1.5 and D1.6	<i>completed</i>
M2	Methodology Concept Designed	WP2/KPB2 deliverables, particularly D2.5 and D2.6	<i>completed</i>



Milestone	Name	Means of achievement	Status
M3	Experimental Verification of Methodology	WP3/KPB3 deliverables, particularly D3.1–D3.4	<i>completed</i>

4. Evaluation of Project Monitoring Indicators

The project description defined monitored measurable indicators (KPIs) expressing the project's expected results and impacts in terms of engagement of research capacity, publication activity, cooperation, project follow-up, intellectual-property protection and private investment. These indicators relate to the project as a whole and its results, not to an individual work package or a specific person in the personnel matrix.

Based on the available supporting documentation, it can be concluded that the project achieved the defined monitoring indicators. Publication, project, dissemination, and cooperation outputs arose continuously in connection with the implementation of individual work packages and served primarily for professional communication of results, obtaining feedback and supporting further use of the PCBRISKMAN framework.

The project also created conditions for further project follow-up, as several project proposals or projects thematically related to the research direction of the project team were identified under other schemes. These projects support further development of digital engineering, artificial intelligence, monitoring, environmental assessment, aviation systems and applied research.

Cooperation links were developed with project partners, the applied sector, private sector and specialist institutions. Cooperation was carried out through joint implementation of work packages, technical consultations, contractual cooperation, workshops, conference activities and knowledge sharing related to the assessment and management of technical and environmental risks. An overview of achievement of the monitoring indicators is presented in the following table.

Table 3 Project KPIs and their achievement

Monitored indicator	Target under the project	Evaluation
Number of outstanding students, doctoral candidates and researchers participating in the project	2	completed
Number of projects submitted under other schemes	4	completed
Number of intellectual-property rights applications	1	completed / according to records
Number of publications	5	completed
Number of collaborations – international, with the private sector and with the applied sector	5	completed / documented in the project records
Private investment	more than 300 000 EUR	reported in separate financial and substantive project documentation

The project team included scientifically and professionally established staff with significant specialist profiles, research and teaching results, and experience in risk management, environmental safety, technical diagnostics, GIS, smart technologies, and applied



development. The indicator was fulfilled because the project involved at least two outstanding researchers or experts with demonstrable expertise relevant to its objectives.

An intellectual-property rights application relevant to the technological and research-and-development environment of the project team was recorded under the monitored indicator (PUV 328-2025).

5. Project Management and Data Management

Work package WP4/KPB4 ensured project management, partner coordination, preparation of deliverables, data management, communication and dissemination of results. Project management was based on the Project Management Plan, which defined the work-package structure, partner roles, implementation schedule and basic communication mechanisms among consortium members.

TUKE, as the beneficiary, and the partners TOMARK, s.r.o. and R-DAS, s.r.o. participated in project implementation. The division of tasks reflected the partners' specialist focus: TUKE ensured coordination, the risk-management technical framework, analytical and methodological parts; TOMARK contributed primarily in aviation and technological inputs; and R-DAS in smart monitoring, data solutions and verification aspects of the model.

Data management was ensured through rules defined in the Data Management Plan. Emphasis was placed on recording, validation, secure storage, backup, controlled distribution and archiving of project data. This data-management setup supported the credibility of project results, their usability in checking deliverables and their availability for further technical work after project completion.

During the monitoring period, the project proceeded in accordance with the currently applicable schedule following the approved change. Substantive implementation was completed on 31 August 2026. The final public WP4/KPB4 deliverables were finalised taking account of completion of work package WP3/KPB3 at M32, so that the public project-implementation summary would also include the results of the verification and evaluation phase. No delays were identified that would prevent achievement of the planned milestones or deliverables, and substantive project implementation was neither interrupted nor suspended.

6. Dissemination and Public Access to Results

Project dissemination was aimed at making the project objectives, implementation and results accessible to the professional community, public administration, the applied sector, project partners and the wider public. Given the environmental and societal importance of POPs/PCB, communicating results was an important part of overall project implementation.

The main dissemination tools included the project website, public work-package reports, specialist events, workshops, conference activities, internal partner communication and ongoing publication of project information. The purpose of these activities was to support transparency, knowledge transfer and further use of project results.

6.1 Project Website and Published Activities

The project website (<https://riskman.lf.tuke.sk/>), shown in Fig. 1, served during project implementation as a public communication and dissemination tool. In addition to basic information on the project, its objectives, partners, funding and deliverables, the website continuously published updates and specialist activities related to the POPs_RISKMANbase project. This ensured transparent communication of project results to the professional community, applied sector, project partners and wider public. The following dissemination activities were published on the project website – Table 4.

Table 4 Overview of dissemination activities on the project website

Activity	Date / period	Nature of activity	Contribution to project dissemination
Theory and Application of Technical Diagnostics – DIS 2025	1. – 2. 10. 2025	international scientific conference	Presentation of the project in the broader professional context of technical diagnostics, maintenance, digitalisation, Industry 4.0, operational safety, aviation applications and sustainability.
Workshop on PCB Risk Management in Eastern Slovakia	3. 12. 2025	specialist workshop	Direct specialist dissemination of project results and objectives concerning PCB burdens, measurement, monitoring, health and environmental impacts, risk management and digital monitoring.
Workshop with SOVA Digital and Siemens PLM	18. 3. 2026	specialist and practical workshop	Linking the project with digital-engineering themes, immersive tools, modelling and digital approaches applicable to the further development of the decision platform.
Public Report on the Results of Work Packages WP1/KPB1– WP3/KPB3	2026	public project deliverables	Progressive public release of WP1/KPB1, WP2/KPB2 and WP3/KPB3 results – from analytical foundations and the methodological framework to verification, assessment of measures and a proposal for

Activity	Date / period	Nature of activity	Contribution to project dissemination
			further development of the PCBRISKMAN model.

According to the published update, the DIS 2025 conference was organised under the auspices of the project and created space for presenting research projects and exchanging experience in digitalisation, Industry 4.0, diagnostics, experimental methods, safety, aviation applications and sustainability.

The Workshop on PCB Risk Management in Eastern Slovakia was directly focused on the current state of measurement and monitoring of PCB burdens in eastern Slovakia. The published programme lists specialist presentations on long-term PCB research results, contamination in eastern Slovakia, geological and environmental aspects, aerosol and PCB measurement, monitoring of PCBs and dioxins in food and feed, PCB risk management, data processing for the PCB Riskman model and innovative monitoring solutions of the TOMARK and R-DAS partners.

The workshop with SOVA Digital and Siemens PLM was published as a specialist workshop held at the Faculty of Aeronautics of TUKE in support of the project. The activity was complemented by a practical workshop aimed at improving understanding of tools and procedures for integrating immersive engineering.

The project website also contains public project deliverables through which the results of individual work packages are progressively made available. Public reports on KPB1 and KPB2 results were published, summarising analytical foundations, the methodological framework, assessment of sources, transport pathways, receptors and environmental factors, risk modelling, GIS processing and the proposed PCB risk-management methodology. In the same way, a public report on WP3/KPB3 results was published, focused on preparation for verification, model checking, the design of measures, calculation of residual risk and a framework for further research.

WORKSHOP SO SPOLOČNOSŤAMI SOVA DIGITAL A
SIEMENS PLM

WORKSHOP



Dňa 18. marca 2026 sa na Leteckej fakulte TUKE uskutočnil odborný workshop, ktorý usporiadala Katedra leteckého inžinierstva v spolupráci so spoločnosťami SOVA Digital a Siemens PLM v rámci podpory projektu Riadenie POPs rizík v kontexte prechodu na udržateľnú bloekonomiku (09I04-03-V02-00050).

[Čítať ďalej >](#)

29 MARCA, 2026 / OD ADMIN

Holistic PCB
Risk Management

ZNAČKY

DIS	KLI	PCB	Siemens PLM
SOVA Digital	Technická diagnostika		

NAJNOVŠIE ČLÁNKY

[Verijná správa o výsledkoch pracovného balíka 2](#)[Verijná správa o výsledkoch pracovného balíka 1](#)[Workshop so spoločnosťami SOVA Digital a Siemens PLM](#)

Fig. 1 Faculty of Aeronautics TUKE Website – POPs_RISKMANbase Project (event visualisation example)

The published updates and public deliverables demonstrate that project dissemination was not limited to formal reporting, but also included specialist events, workshops, conference activities and ongoing release of results. The website therefore served as a communication, documentation and dissemination tool for the project.

7. Project Contribution and Alignment with Strategic Priorities

The project provides a technical contribution to developing a systematic approach to assessing and managing risks of POPs/PCB environmental burdens. The established framework links source identification, transport pathways, receptors, risk modelling, GIS processing, the design of measures, assessment of residual risk and preparation of technical-economic assessment of alternatives.

The project results align with the strategic priorities of the Slovak Republic and the European Union in environmental protection, reduction of environmental burdens, public-health protection, digital transformation and transition to a sustainable bioeconomy. The project supports the principles of the European Green Deal, zero pollution, open science and data-driven decision-making.

The societal contribution lies in supporting transparent decisions on monitoring and mitigation priorities at PCB-burdened sites. The environmental contribution lies in a better understanding of PCB behaviour in the water–sediment–soil–air–biota system and in the ability to assess more precisely whether action is needed at the source, to limit contaminant transport or to reduce receptor exposure.

The project deliverables can contribute to public-health protection, reducing environmental risks, remediation of environmentally burdened areas and strengthening trust in decisions based on scientific evidence, data, modelling and continuous verification of the effectiveness of interventions.

8. Sustainability of Results and Further Use

The project results provide a basis for further use of the PCBRISKMAN system in research, public administration and applied practice. The established framework can be further developed towards a digital decision platform linking a computational model, GIS visualisation, monitoring, a measures catalogue, CAPEX/OPEX inputs, uncertainty assessment and support for future CBA/MCDA comparison.

The framework can also be applied beyond PCB issues, especially in assessing environmental burdens, contaminated sediments, industrial sites, dust and water transport pathways or other environmental risks. The project results therefore provide a basis for further research, pilot verification and participation in national and European initiatives supporting clean technologies, digital transformation, zero pollution and remediation of environmentally burdened areas.

Long-term sustainability of the results will be supported by archiving project data, public access to deliverables, use of the project website and the possibility of further technical development of the methodology in follow-up research and applied projects.

Conclusion

The POPs_RISKMANbase project established a coherent technical framework for assessing and managing risks associated with POPs, primarily PCBs, in the context of the transition to a sustainable bioeconomy. WP1/KPB1 deliverables created an analytical foundation for identifying sources, transport pathways, receptors and critical scenarios. WP2/KPB2 deliverables developed the methodological, data, modelling and GIS framework for risk assessment in space and time. WP3/KPB3 deliverables built on these results through preparation for verification, checking the model's computational logic, design of measures, calculation of residual risk and a framework for further application-specific research.

WP4/KPB4 ensured project management, data management, communication among partners, publication of information and dissemination of results. The project website and public reports prepared support project transparency and accessibility of its results to the professional community and wider public.

The project thus fulfilled its role of establishing a knowledge base and methodological support for active management of PCB risks. The project results provide a basis for further verification, development of the PCB_RISKMAN digital decision platform, preparation of future research projects and support for decision-making in the remediation of environmentally burdened areas.