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Management of Environmental Risks Related to the Use of Lead Ammunition at Outdoor Sports Facilities (Shooting Ranges)

Guidelines on the Best Available Practices

Helsinki
February 10, 2020

The research was conducted with the participation of geochemistry specialists from the Department of Geology of the Lomonosov Moscow State University at the request of the national public sports organization – the Federation of Rifle and Pistol Shooting and Shotgun Shooting "the Shooting Union of Russia"

The objective is to identify the potential impact of using lead ammunition on the environment components, in order to manage the environmental risks of outdoor sports facilities (shooting ranges) operation

The report is prepared at the request of the European Chemicals Agency (ECHA)

INTRODUCTION

The operation of shooting ranges causes dispersion of metallic lead in the form of ammunition over a limited area of a shooting facility.

The management of outdoor sports facilities using lead ammunition is impossible without understanding the transformation factors and evaluating the potential environmental impact.

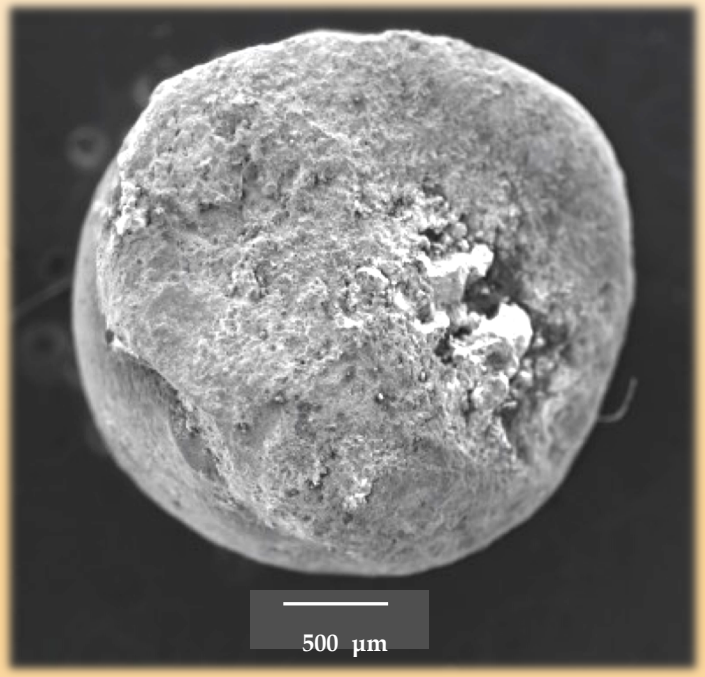
The report does not cover such facilities as:

- indoor shooting ranges,
- military shooting ranges,
- hunting areas.

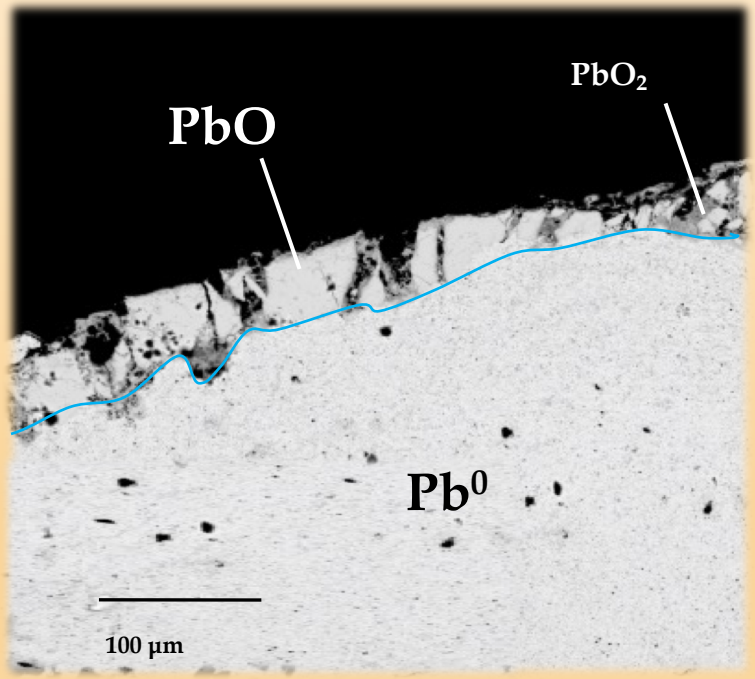
PHYSICAL AND CHEMICAL PROPERTIES OF LEAD

1. Lead is considered to be a relatively unreactive metal which is stable in neutral environments in the absence of oxygen.
2. Under natural conditions metallic lead reacts with the ambient oxygen quite fast, with a continuous oxide coating is formed on the lead surface.

General view of the surface of used gunshot



Cross-sectional view of the shot surface



When exposed to air, lead is relatively inert because oxide coating is formed on their surface and protects it against further transformation

PHYSICAL AND CHEMICAL PROPERTIES OF LEAD

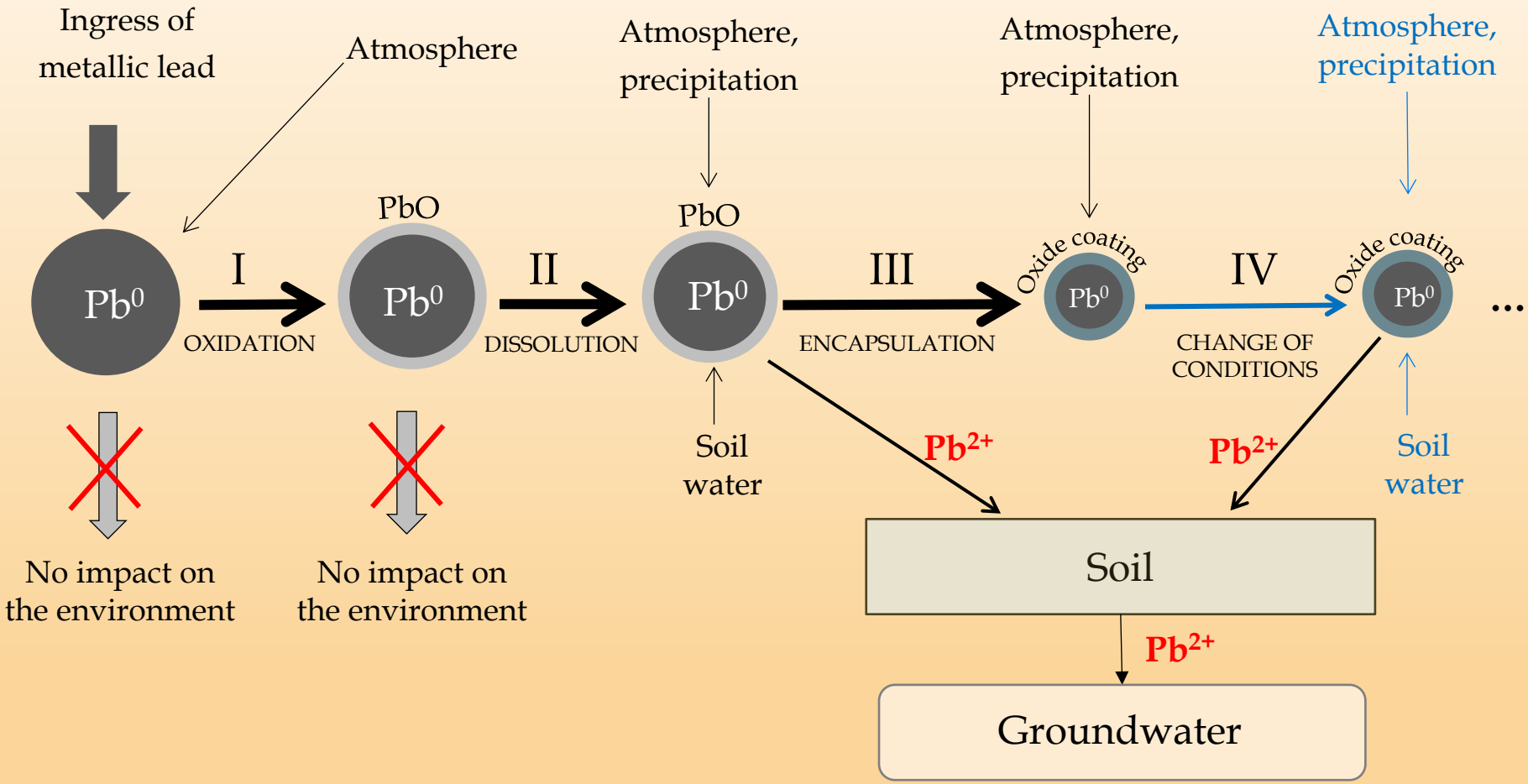
Comparison of metal corrosion rates, µm/year
(for urban atmosphere)

Lead	Aluminium	Copper	Nickel	Zinc	Steel
0.4	0.8	1.2	3.3	5	12

(Uhlig, Revie, 1989)

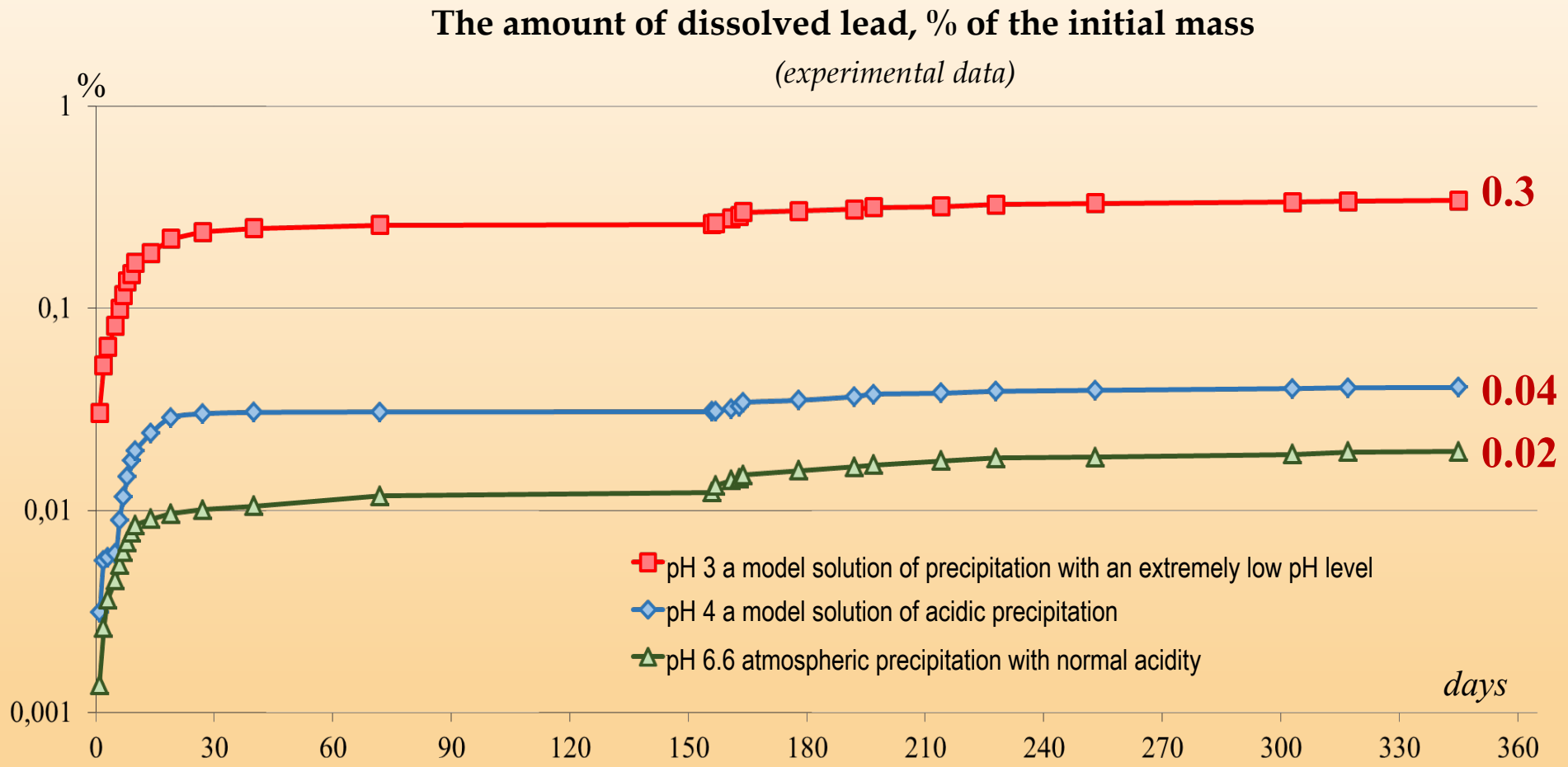
Lead is weakly prone to corrosion when exposed to ambient air
(as compared to other metals)

PATTERN OF TRANSFORMATION OF LEAD SHOT IN THE ENVIRONMENT



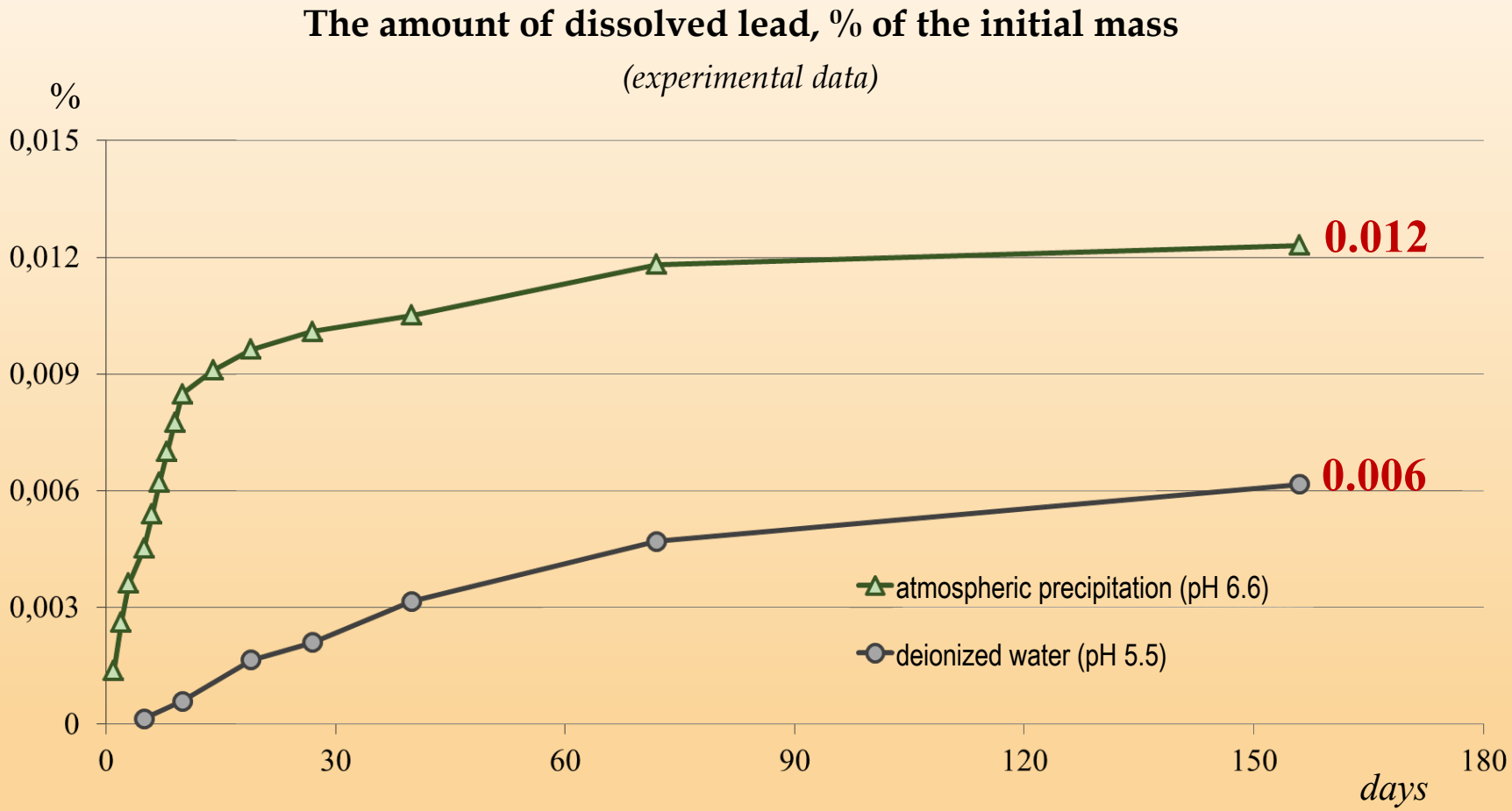
The contact between shot and atmospheric precipitation and soil water is the reason why lead ions are released into soils after the dissolution of the oxide coating on the shot surface

THE EFFECT OF PRECIPITATION ACIDITY ON THE DISSOLUTION OF LEAD SHOT



Contact of lead shot with atmospheric precipitation results in dissolution of oxide coating on the shot surface. The dissolution rate is 0.02-0.3% per year

IMPACT OF CO_2 CONTENT IN PRECIPITATION ON THE DISSOLUTION OF LEAD SHOT

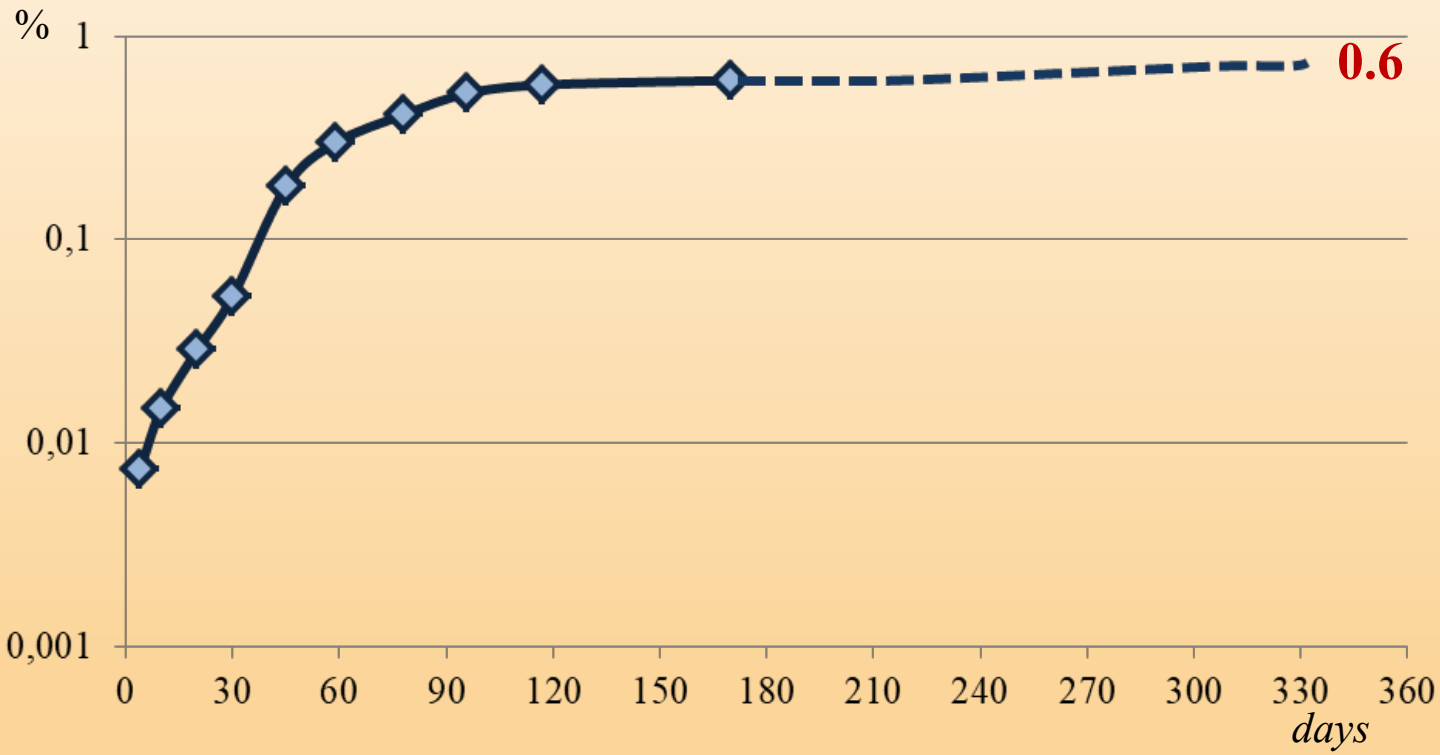


The presence of CO_2 in atmospheric precipitation increases the rate of dissolution of the oxide coating on the shot surface

THE EFFECT OF HUMIC ACIDS ON THE DISSOLUTION OF LEAD SHOT IN SOIL

The amount of dissolved lead, % of the initial mass

(experimental data)

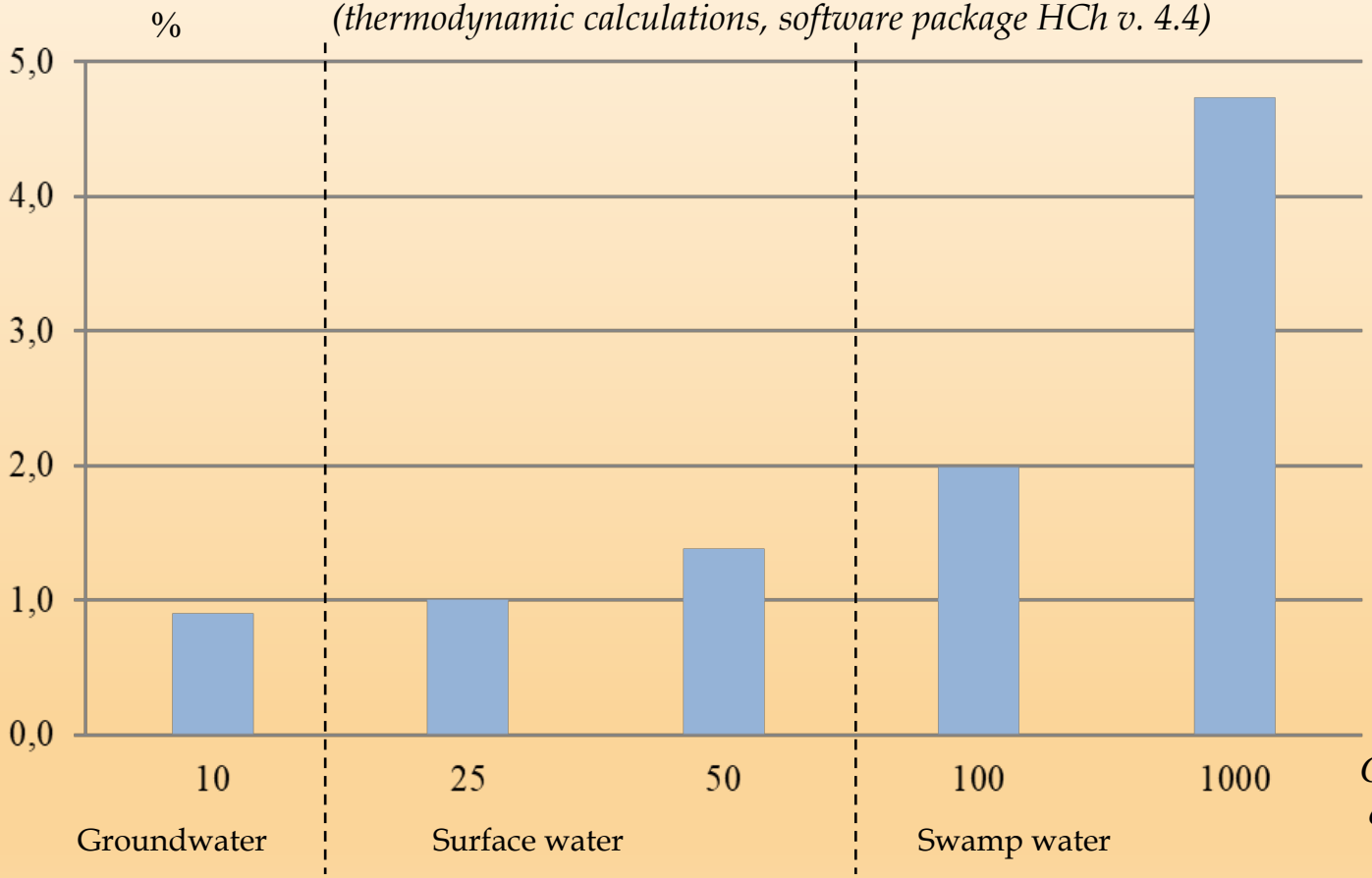


The contact between shot and humic acids of soil water results in the highest rate of oxide coating dissolution

THE EFFECT OF CONCENTRATION OF ORGANIC ACIDS IN SOILS ON THE DISSOLUTION OF LEAD SHOT

The potential share of dissolved Pb in case of an increase in the concentration of organic acids

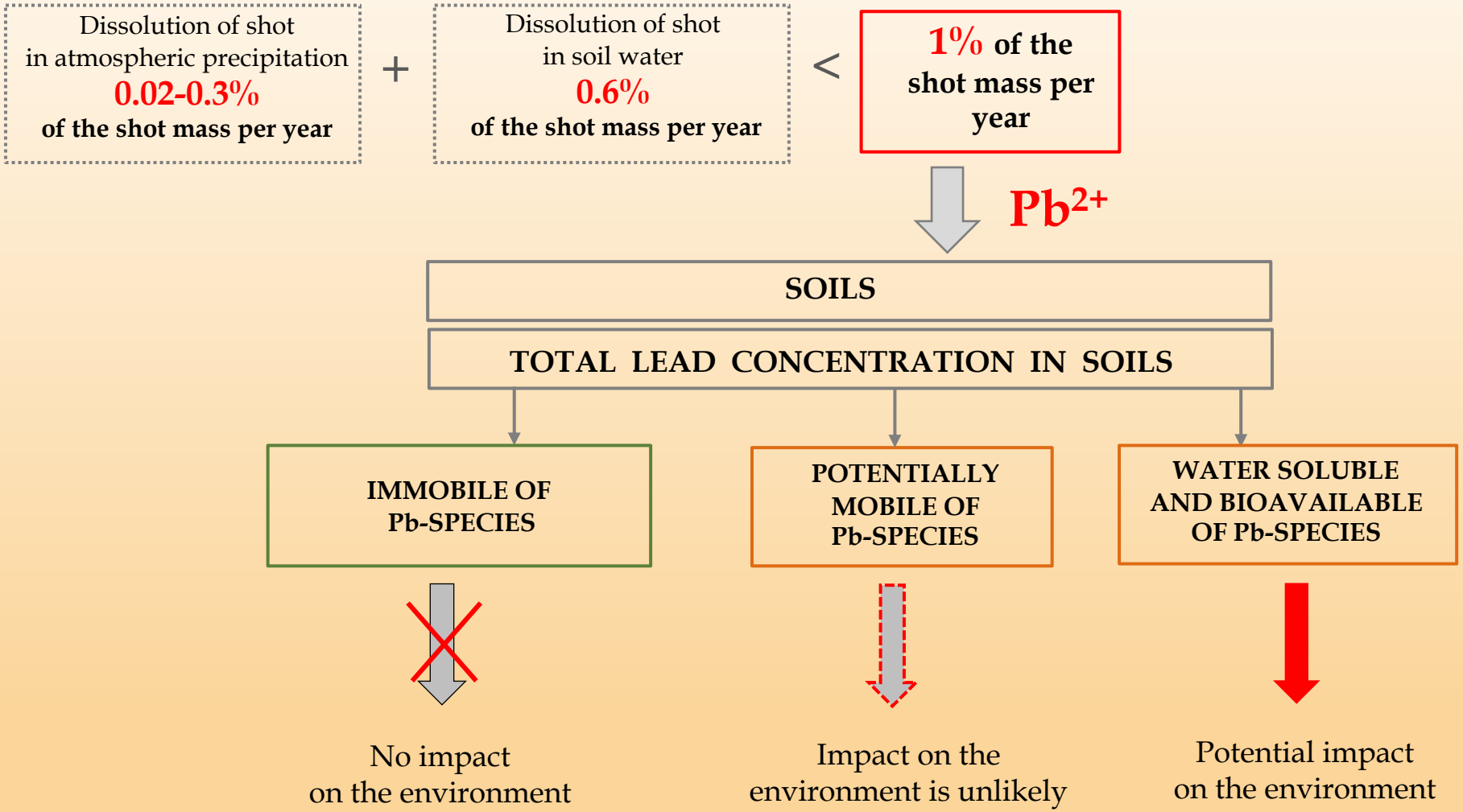
(thermodynamic calculations, software package HCh v. 4.4)



Calculation in case of soil water average concentration of CO_2 - 25 mg/L

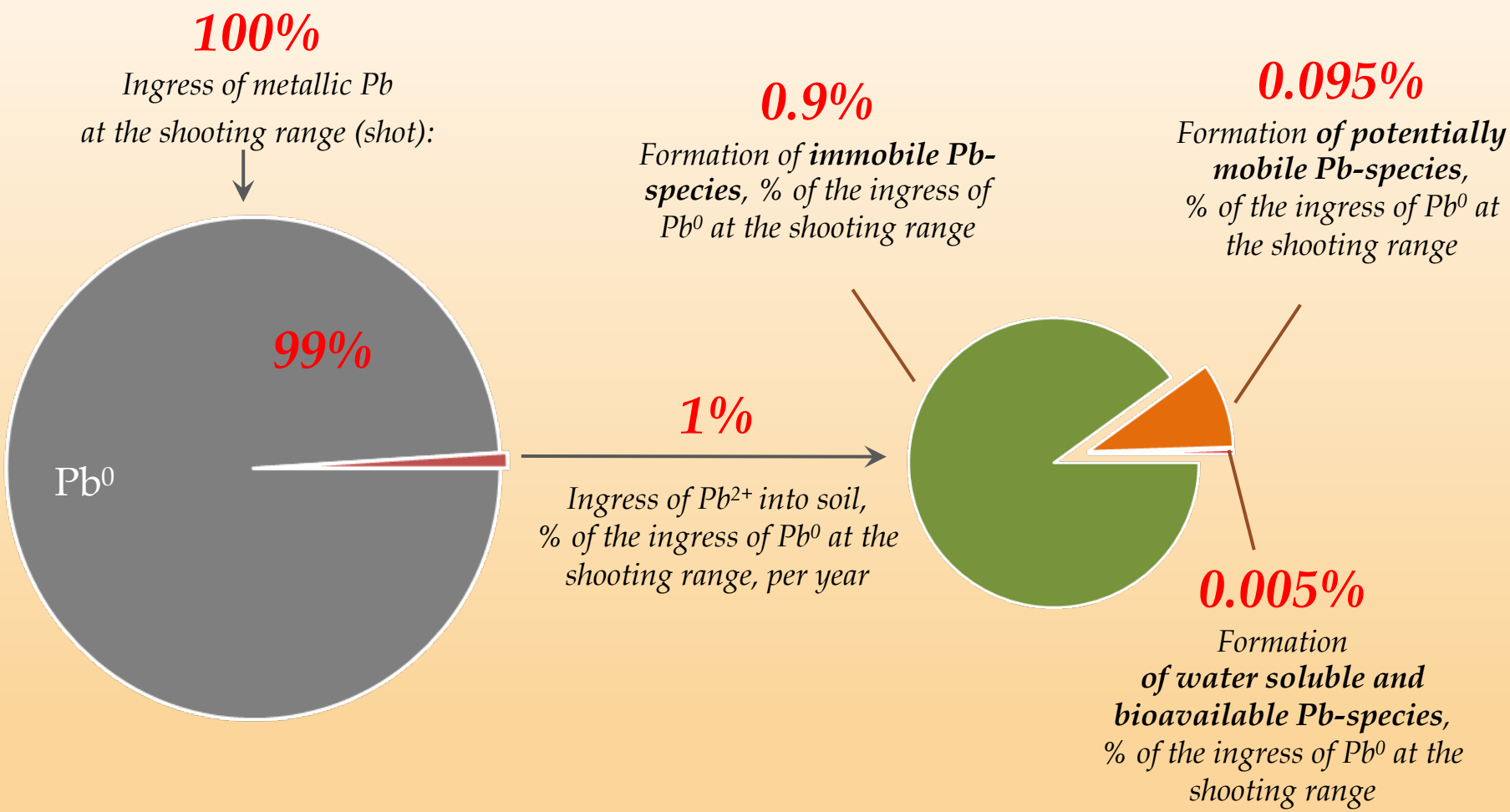
An increase in the concentration of organic acids in soil water increases the dissolution rate of the oxide coating on the shot surface

LEAD INGRESS INTO SOILS



In order to manage environmental risks, it is necessary to control the content of water soluble and bioavailable Pb-species in soils

BALANCE OF LEAD AT A SHOOTING RANGE



The resistance of metallic lead to transformation, together with the tendency to form immobile Pb-species in soils result in a negligibly small quantity of its water soluble and bioavailable compounds.

ENVIRONMENTAL RISK MANAGEMENT AT SHOOTING RANGES

Most sports shooting ranges are isolated facilities fitted with special equipment

ENCLOSED SHOOTING RANGE

Structure

- firing lane equipment
- confined area (earthen berms and backstops)
- regulation of shotfall zone

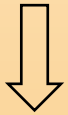
Environmental protection equipment

- covering of the shotfall zone with the adjacent accumulation area
- shot curtain
- bullet traps

Lead shot collection activities

Annual reclamation and recycling of shot from the accumulation area – up to 80% of the shot ingress

Regular removal of lead shot remain from soils at the shooting range



Maximum lead shot removal from the area at minimum costs

ENCLOSED SHOOTING RANGE

A SHOT CURTAIN AT A SHOOTING RANGE

BULLET TRAPS AT A SHOOTING RANGE

REMOVAL OF LEAD SHOT FROM SOILS

There will be a video here showing lead shot reclamation from soils

PARTLY ENCLOSED SHOOTING RANGE

Structure

- firing lane equipment
- confined area (earthen berms and backstops)
- regulation of shotfall zone

Environmental protection equipment

- ~~covering of the shotfall zone with the adjacent accumulation area~~
- ~~shot curtain~~
- ~~bullet traps~~

Lead shot collection activities

Regular shot reclamation which frequency is determined by:

- technical capability,
- economic feasibility,
- national legislation requirements

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Partial lead removal at the shooting range

PARTLY ENCLOSED SHOOTING RANGE

OUTDOOR SHOOTING RANGE

Structure

- firing lane equipment
- confined area (earthen berms and backstops)
- regulation of shotfall zone

Environmental protection equipment

- covering of the shotfall zone with the adjacent accumulation area
- shot curtain
- bullet traps

Lead shot collection activities

Removal of lead shot from soils is difficult

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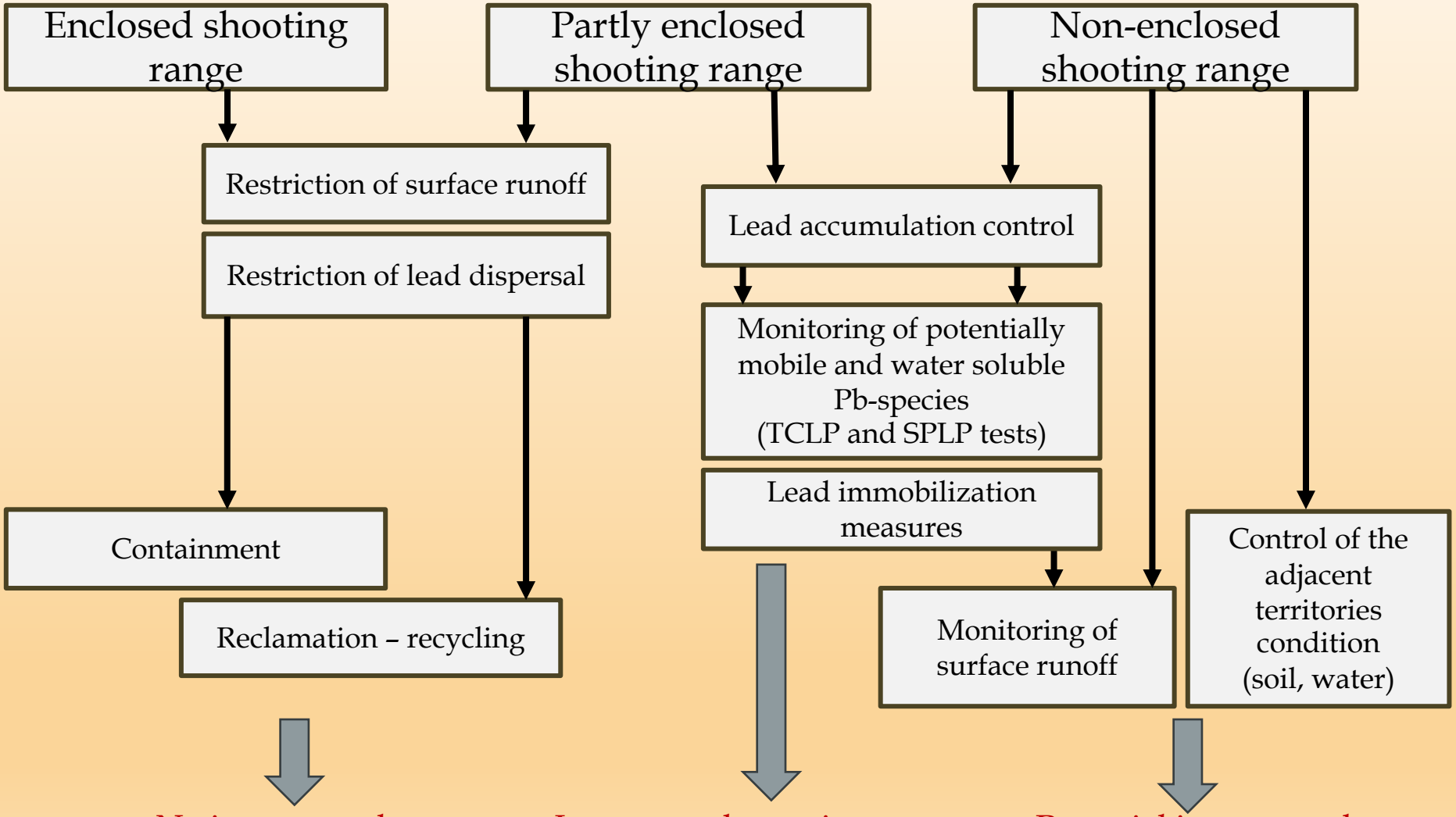
Lead shot is accumulated both on the shooting range territory and off-site.

RISK MANAGEMENT

ISSF ALGORITHMS



SUMMARY

- Shooting ranges are isolated facilities, and their activities can be managed.
- The proposed management structure represents an economically feasible and risk-oriented approach to the assessment of environmental impact of shooting ranges, with the goal to prevent such impact outside of the facilities:
  - economically feasible measures include metallic lead reclamation and recycling;
  - the risk-oriented approach is based on the understanding of the potential hazards of only water-soluble lead species which can migrate in adjacent media and constitute under 0.005% of the total amount of annual metal ingress at the shooting range.
- Under the conditions of discrepancies in EU member states legislation and lack of unified regulations, risk management presumes restriction of contact between the object and water resources and monitoring of water soluble and potentially mobile lead species in soils.

ISSF

Thank you for your attention!