LABORATORY WORK 2
"RISK ASSESSMENT FOR HUMAN HEALTH FROM CHEMICAL EXPOSURE"
Instructional lines

Objective:

- to learn computer program "Risk Assessment for Windows"
- to evaluate cancerogenic risk (R canc) и noncancerogenic risk ID (index of damage) for human health from chemical exposure based on geochemical dates of soil pollution.
- to master main definitions and terms, used at risk assessment;
- to make inference about acceptability of risk for human health based on obtained data результатов

The methods of human health risk assessment have been intensively developed lately in some European countries, Great Britain, USA, and Russia. The modern science testifies the absence of a threshold impact for a lot of chemical contaminants. Risk is the likelihood that a harmful consequence will occur as a result of an action. Human health risk assessment evaluates the probability of health effects as a result of potentially hazardous behaviors.

Traditionally, such assessments have focused on the probability of increased disease in human populations. The approach follows the four steps recommended by the United States National Academy of Sciences:

1. Hazard identification;
2. Dose-response assessment;
3. Exposure assessment;
4. Risk characterisation.

According to Environmental Protection Agency USA Approach and Guideline of the State Committee for Sanitary and Epidemiological Oversight under the Russian Ministry of Public Health, one mathematical formula that determines an individual cancerogeneous risk from chemical exposures is

$$R_{ind} = 1 - \exp^{(-SF \times LADD)}$$

R_{ind} – individual cancerogeneous risk,

SF - Slope Factor, or Unit Risk, $(mg/kg \times day)^{-1}$, reference date are used;

$$LADD = [C \times CR \times ED \times EF] / [BW \times AT \times 365]$$

LADD - Living Average Daily Dose, mg/kg x day,

C – the average concentration of the chemical substances, affecting during the exposure, mg/m^3;

CR- Contact Rate, for inhalation affect – inspiratory rate, m^3/day;

ED- Exposure Duration, years;

EF -Exposure Frequency, day/year;

BW – Body Weight, kg;

AT - Average Time, or average life expectancy, years

The noncancerogeneous risk, or Index Damage (HQ) is calculated by the equation

$$HQ = LADD/RfD$$

HQ - Index Damage

LADD - Living Average Daily Dose, mg/kg x day,

RfD – Referent (harmless) Dose, mg/kg x day, reference date are used.

Risk level	R_{ind}	HQ	
Extremely high	10^{-1}	More than 5	Unacceptable neither for the population, nor for professionals. Other actions for risk decrease
High	10^{-1}-10^{-3}		Carrying out of emergency improving and other actions for risk decrease is necessary
Average	10^{-3}-10^{-4}	1 - 5	Acceptable for professionals and unacceptable for the population as a whole; occurrence of such risk demands planned improving actions in the conditions of the inhabited sites
Low	10^{-4}-10^{-5}	0,1 - 1	Demands of constant control
	10^{-5}-10^{-6}		Corresponds to a zone of conditionally (admissible) risk; at this level the majority of hygienic standards recommended by the international organizations for the population as a whole is established
Minimum	Less than 10^{-6}	Less than 0,1	Corresponds to one additional case of serious disease or death per 1 million persons suffered from the effect. Such risks are perceived by people as negligibly small, do not differ from usual, daily ones. Do not demand for additional measures in their decrease, are subject to only the periodic control

Software package “RISK ASSISTANT” is a commercial software to assess health risk from toxic contamination at local sites, used for the risk evaluation for health, caused by the chemical substances in drinking, surface, underground water, soil and atmospheric air. It is necessary to determine the chemical substances concentrations in water, soil and atmospheric air and know the impact conditions for using RA. Conceptual models, ecological effects, and other factors are incorporated into this software for the definition of assessments.

Description of the computer program “Risk Assessment for Windows”

Table 1

Risk*Assistant	Risk*Assistant for Windows				
Version	1.1	Subgroup	Human Health	Media	Surface Water
Date	1995	Organization	The Hampshire Research Institute		

Function	To assess exposure and risks to human health from toxic chemicals at contaminated sites. User can quickly estimate risks to human health from toxic chemicals in the environment at any site, using basic information on local contamination.
Assumptions	The assumptions are similar to those expressed in EPA Risk Assessment Guidance for Superfund and the Exposure Factors Handbook (i.e., the assumptions are dependent on the user's level of detail in the input parameters).
Capabilities	Software contains "canned" risk algorithms for a more rapid calculation of human exposure and risk. The program is very flexible as it allows the user to conduct either a rough "screening level" or an in-depth risk assessment. The whole structure for a multimedia human health risk assessment is straightforward and transparent. The software package also contains "Stream* Model", a smaller computer program that computes waste load dilution and exposure concentrations based on the local stream hydrology and the industrial discharge rate.
Strengths	This is a fairly user-friendly model which allows a lot of flexibility with regard to input at all stages of a risk assessment. "Quick*Risk" allows a very fast screening analysis by forcing default values. The internal databases are comprehensive and will allow updating through online research (e.g., EPA's IRIS). The model covers all types of media and every available human exposure pathway.
Weaknesses	Fairly steep learning curve for the uninitiated user. Model version (1.1) has not been upgraded since 1995, although the website does contain program updates that can be downloaded to correct some deficiencies that were apparently requested from user feedback.
Applications	None specified in documentation.
Inputs	Some inputs for various types of parameters can be chosen from the internal databases, some can be user-specified. Inputs are required for different exposure scenarios that include outdoor air, swimming, ingestion of food, water, soil, and dust. Need to supply concentrations of various contaminants in different types of media.
Output	Excess lifetime cancer risk for carcinogens. Hazard quotients and indices for non-carcinogens. "Stream * Model" will provide instream concentrations based on user-specified inputs for a particular facility or industry.
Databases	EPA's Integrated Risk Information System (IRIS), EPA's Health Effects Assessment Summary Tables (HEAST), New Jersey toxic hazard data, and California Environmental Protection Agency (Proposition 65) toxic hazard data. Also contains a chemical hazard database (user-specified).
Documentation	Users’ manuals for main program and stream model application available (with purchase of program); refer to website and citation.

Training	For additional information, send email to jhoway@hampshire.org or call 703/684-5203.
Website	(no centralized location online; refer to www.hampshire.org)
Supplement	Thistle Publishing (www.thistlepublishing.com) provided distribution of model and documentation at the time of this writing; however, Chemistry Software (www.chemistry-software.com) is expected to take over software sales.
Citation	Risk*Assistant(TM) for Windows (235 pages) and Risk*Assistant(TM) for Windows, Stream Model (39 pages).
Complexity	Moderate
Stochasticity	Stochastic
Temporality	Steady state
Spatiality	(unknown)
Prerequisite	M.S. in ecology, toxicology, biology would be helpful; 3-4 years experience in risk assessment is also recommended.
Cost	$395
Source Code	Inquire at Hampshire Research Institute (jhoway@hampshire.org)
Platform	PC with Windows
Design Form	Bundled System Component
Language	Visual Basic
Comment	Hampshire Research Institute has entered into a multi-year cooperative agreement with U.S. EPA - with support from USDA - to develop "Aggregate and Cumulative Risk Assessment Software". HRI will widely distribute the resulting Windows-based software to interested users.

1. Instructions

- learn the code description and find out code
- input given data for simulations
-fill in the blanks of the Table 2 with output data of simulation
- perform the report.

The report should concern
Objective
Designations of the code "RA"
Description of the work and sequence of operation procedures using screen-shot
Presentation of calculated results (Table 2)
Making of inference about acceptability of risk for human health based on obtained results

Description of toxic properties of more dangerous contaminants (Cr, Ba,Sb)

Diagram showing contribution of more dangerous contaminants into total risk

Conclusions

Explanations to table 2

№/№ столбца	Информация, содержащаяся в столбце
1	Название элемента, обнаруженного в среде
1	Name of element in soil
2	Предполагаемая форма нахождения
2	Substance in data base
3	Конц. в среде, мг/кг – концентрация элемента в среде, по условиям задачи
3	Concentration in soil, mg/kg
4	Конц. После переноса, мг/кг – концентрация в среде после переноса, рассчитывает программа, см. по ходу Отчета…Все последующие величины рассчитывает программа, Вам нужно их найти в Отчете…
4	Concentration in air after transfer, are calculated using model of transfer
5	Пер.ССД, мг/кг/с – среднесуточная доза при пероральном поступлении
5	Peroral average daily dose at peroral intake to human body- ADD per
6	ИК (ингаляционная концентрация), мг/куб.м – Концентрация х(период воздействия в годах/продолжительность жизни в годах)
6	Inhalation Concentration (IC)
7	Пер. ССДЖ:, мг/кг/с - Среднесуточная Доза в течение Жизни при пероральном поступлении, Пер.ССДЖ = ССД х (период воздействия в годах/продолжительность жизни в годах)
	Peroral life average daily dose at peroral intake to human body during all life, LADD
8	Инг.ОК, мг/куб.м - Отрегулированная Концентрация (ОК) для ингаляционных экспозиций – эквивалентна экспозиционной концентрации, учитывающей частоту и продолжительности воздействия и интенсивности дыхания.
8	Normalized Inhalation concentration, takes account of frequency and duration impact, intensivity of respiration
9	КО пер. (не канц.) показатель неканцерогенного риска – коэффициент опасности при пероральном воздействии, КО=ССД/ПД (отношение среднесуточной дозы к пороговой дозе, пороговая доза это максимальная суточная доза, не вызывающая токсического эффекта). Настоящая программа пользуется базой данных IRIS по канцерогенным и неканцерогенным свойствам веществ
9	ID Index of Damage(ing) = LADD/ threshold dose –noncanc risk
10	КО инг. (не канц) - коэффициент опасности при ингаляционном воздействии, КО=ИК/ПК (отношение ингаляционной концентрации к пороговой концентрации), показатель неканцерогенного риска. Пороговая концентрация это максимальная концентрация, не вызывающая токсического эффекта
10	ID Index of Damage(ing) = IC/ threshold conc.-noncanc. Risk
11	КО общ. = КО пер. + КО инг. – обобщенный показатель неканцерогенного риска по каждому их элементов. Далее суммирование проводится по всем элементам (предпоследняя строчка в таблице)
11	ID Index of Damage(total) =ID Index of Damage(ing)+ ID Index of Damage(ing)
12	R инд. $_{канц}$ (пер). - Индивидуальный риск– вероятность смерти от ракового заболевания при пероральном воздействии данного канцерогена.
	R ind.canc (per)
13	R инд. $_{канц}$ (инг.) - Индивидуальный риск– вероятность смерти от ракового

	заболевания при ингаляционном воздействии данного канцерогена.
	R ind.canc (ing)
14	R ind.canc (total)

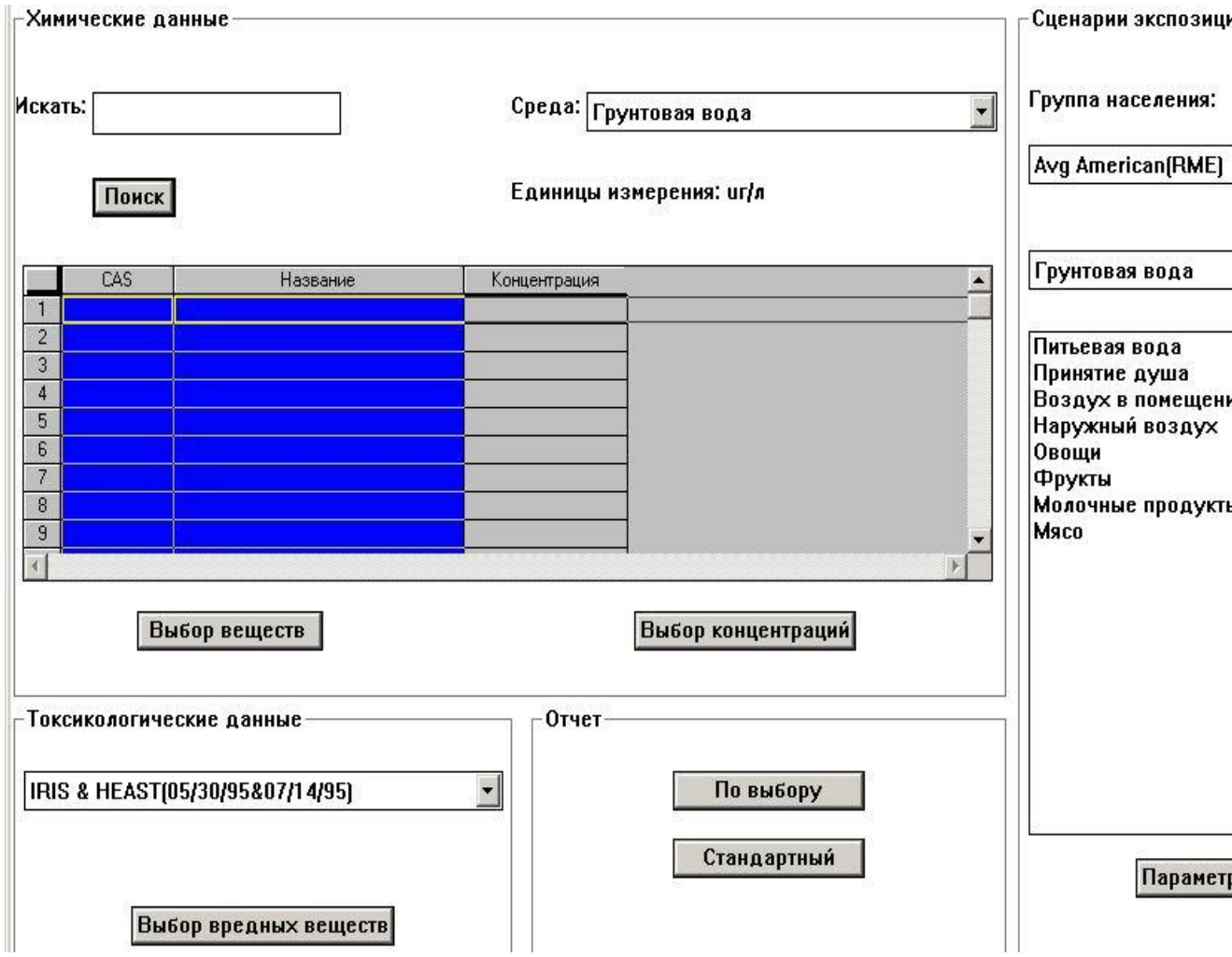

Table 2

Number of variant…

Place…

Элемент	Форма нахождения	Конц. в среде, мг/кг	Конц. после переноса,	пер. ССД мг/кг/с	ИК мг/куб.м	пер.ССДЖ мг/кг/с	инг.ОК мг/куб.м	КО пер. неканц	КО инг. неканц	КО общ неканц	Риск пер. канц.	Риск инг. канц.	Риск общ. канц.
element	Substance in data base	Conc in soil	Conc in air	ADD per	IC	LADD (per)	IC (norm)	ID (per)	ID (ing)	ID (total)	R ind.canc (per)	R ind.canc (ing)	R ind.canc (total)
1	2	3	4	5	6	7	8	9	10	11	12	13	14
кобальт													
торий													
хром													
скандий													
сурьма													
барий													
рубидий													
цезий													
бром													
уран													
TOTAL ID													
TOTAL R ind													